STATE OF THE SOUND 2004

PUGET SOUND
ACTION TEAM

Cover photographs
Center: orcas / Center for Whale Research
Top circle: scalyhead sculpin / Jim Ramaglia
Left circle: clown nudibranch (sea slug) / Jim Ramaglia
Right circle: red rock crabs / Jim Ramaglia

A pair of red rock crabs / Jim Ramaglia

Mission: Protect and Restore Puget Sound

State of the Sound 2004
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Chapter photos
English sole / Randy Shuman
South Indian Island Park in Jefferson County
Copper rockfish / Jim Ramaglia

Giant green sea anemones

State of the Sound 2004
EXECUTIVE SUMMARY

Introduction

How is Puget Sound doing? Are efforts to protect and restore the Sound on the right track? After years of work to clean up pollution, protect habitat, and restore degraded areas around the Sound, how much remains to be done?

The *State of the Sound 2004* provides answers about the health of Puget Sound and Washington State's work to protect it.

The answers reflect a mix of positive and negative news. Thousands of committed people in the government and private sectors are accomplishing a great deal of excellent work that is leading to significant improvements in certain areas. Yet the Sound continues to show troubling evidence of decline. Most notably, the health of the Sound's living resources—orca, rockfish, marine birds, and others—appear to be in jeopardy. Their plight may be the signal of a broader systemic problem.

The goal of a healthy Puget Sound now and for future generations can be achieved, but to achieve it will require redoubling efforts and expanding the scale of work. To be successful, new problems must be prevented from being created, activities to protect and restore must be scaled up, a broader constituency in conservation and restoration efforts must be engaged, and the overall investment in this work must be significantly increased.

State of the Sound 2004 reports on the health of Puget Sound, focusing on 15 environmental indicators that provide insight into the condition of the Sound's water and submerged lands, habitats, and species, and the threats to these resources. *State of the Sound 2004* also reports on the progress of the Puget Sound Action Team partnership (Action Team partnership) to improve Puget Sound's health in 2003 and 2004. The Action Team partnership defines, coordinates, and implements Washington State's environmental agenda for Puget Sound. Since the partnership credits much of the progress in the Sound to the actions of federal, local, and tribal governments, organizations, businesses, and citizens, this report includes examples of their work.

State of the Sound's Water and Submerged Lands

More than 100 years of industrial pollution and urban development have created underwater hot spots of highly contaminated sediments in many of Puget Sound's urban bays. More than 5,700 acres of aquatic lands currently exceed safe levels of toxic contamination. Cleanup is underway on 530 of these acres. In 2003 and 2004, the Washington Department of Ecology (Ecology) evaluated an additional 4,516 acres of submerged lands to determine the need for cleanup.

In addition to cleanups, the Action Team partnership works to prevent the contamination of new sites and the recontamination of cleaned sites by controlling pollutant sources. The top layer of sediments in Puget Sound is cleaner today as a result. However, a slew of new contaminants, such as pharmaceuticals, soaps, cosmetics, and flame retardants find their way into the Sound in billions of gallons of wastewater and stormwater. The potential harm to marine life from these new pollutants is not fully known. The Action Team partnership is focusing work to control the release of persistent bioaccumulative toxics, such as mercury and flame retardants.

Don Paulson

Stormwater runoff has polluted more than 30 percent of the state's waters.

Nutrients from human and animal waste carried to Puget Sound in wastewater discharges, stormwater, and groundwater are another significant water pollution problem. In Hood Canal, for example, nutrient pollution stimulates excessive algae blooms, which rob the water—and fish—of oxygen when the algae decay. Low levels of dissolved oxygen have caused extensive fish kills recently and could threaten the long-term viability of marine life in Hood Canal. Scientists and resource managers are studying the canal to determine how much of the problem is due to human versus natural causes. The Action Team partnership is coordinating and funding corrective actions to reduce the amount of nutrients that enter the canal from human sources.

Pathogens from human and animal waste have closed 30,000 acres of commercial shellfish beds since 1980. Local and tribal governments, environmental organizations, and businesses worked hard to identify and clean up sources of pollution, and their efforts resulted in an overall upgrade or reopening of 1,655 acres of shellfish harvest areas during the past two years. However, the list of shellfish beds on the brink of closure has doubled to 18 since 1997.

Ecology estimates that stormwater runoff has polluted more than 30 percent of the state's waters. Local governments are working hard to manage stormwater to keep pace with growing urban areas. The Action Team partnership provides technical assistance and funding to help them meet these challenges. Seventy-five smaller municipalities will soon join the more populated cities and counties to manage stormwater under permits issued by Ecology. The state supports low impact development (LID) pilot projects, which reduce stormwater runoff by mimicking natural drainage patterns.

State of Sound's Habitat

Urban development is fragmenting Puget Sound's habitat. Two hundred forty square miles of forest were converted into housing units and business complexes during an eight-year study period in the 1990s. One-third of Puget Sound's shorelines (about 800 miles) have been impaired by bulkheads, armoring, and dredging. The continuing loss of habitat is a critical threat to Puget Sound's web of life.

To stem these losses, the Action Team partnership and local communities regulate development, acquire and restore important habitat, control invasive species, and educate citizens about how they can protect Puget Sound. During the next few years, local governments will update critical areas ordinances and shoreline management programs, using new state guidance that presents the best available science and policies to protect the Sound. These updates provide an important opportunity to protect habitat, such as eelgrass and forage fish spawning beaches, as well as the natural processes that keep the Sound's ecosystem healthy.

In the past two years, state and local agencies permanently protected 5,200 acres through aquisition and restored another 1,700 acres of estuarine, riparian, upland, and wetland habitat. The Washington Department of Agriculture (Agriculture) removed 80 acres of spartina, an invasive grass that threatens mudflats and native marshes. The Action Team's Public Involvement and Education fund (PIE) provided $530,000 for 39 projects that teach people how to become better stewards of Puget Sound.

State of the Sound's Species

Perhaps the most alarming effects of pollution and habitat loss show up in the Sound's living resources. Declining populations of rockfish, salmon, forage fish, marine birds, and orcas during the past few decades are signs that the whole Puget Sound ecosystem may be at risk. The federal and Washington State governments are currently protecting 40 different Puget Sound species because the survival of the species is in jeopardy.

Slow growing species with low birth rates, such as rockfish and orcas, are particularly at risk. Some rockfish populations are down 90 percent from their historic levels. While the Puget Sound orca population has shown a modest increase in recent years, the state listed the population as endangered in 2004. Surf scoters, western grebes, and a number of other marine birds have declined dramatically in Puget Sound—grebe populations by about 95 percent during the past 20 years, and south Sound surf scoter populations by almost 57 percent since 1995. Of the 19 herring stocks in Puget Sound, one is depressed and two are in critical decline. Because herring are food for so many species, any decline sends repercussions throughout the Puget Sound food web.

The Action Team partnership protects species by preserving and restoring habitat, cleaning up pollution, keeping key elements of the food web intact, and reducing human disturbances.

Conclusion

While the Puget Sound appears as beautiful as ever, its rich web of life is at risk. The building blocks of a healthy environment—clean water, sufficient habitat, and an intact food web—continue to be under serious pressure.

Unfortunately, there isn't a simple solution in the quest to preserve a healthy Puget Sound and pass it on to future generations. The region's significant population growth, with accompanying increases in paved surfaces; alteration and loss of habitat; and toxic contaminants entering the water, all challenge government and private-sector efforts to keep pace with, or get ahead of, the problems.

As a result, Puget Sound is a treasure that may be lost in increments—one natural shoreline, stream segment, and eelgrass bed at a time. Much valuable habitat is already gone. Further losses must be avoided wherever possible. Preventing harm is a far more practical and cost-effective strategy than trying to restore damaged areas.

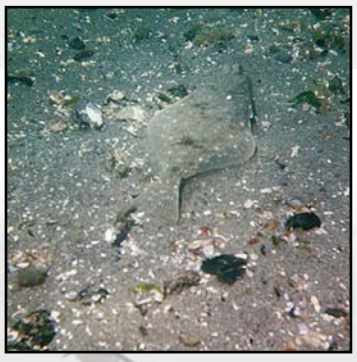
The Action Team partnership and communities around the Sound are making progress on a variety of fronts to protect and sustain Puget Sound. That progress is not enough. The coalition working to save the Sound must be expanded and broadened, and new thinking and approaches welcomed into the mix.

Safeguarding the health of Puget Sound for future generations calls for additional investments of time and money. Laudable as they are, today's efforts aren't reaching the scale necessary to get the job done. Increasing our investment is required.

The Action Team partnership's work plan for 2005-2007 outlines immediate next steps to tackle Puget Sound's most vexing environmental problems. The plan outlines seven core priorities, spells out measurable results, and details the budget required to achieve those results. It also shows where additional resources can be invested to accelerate progress. The *2005-2007 Puget Sound Conservation and Recovery Plan* may be accessed on the Action Team's Web site at www.psat.wa.gov.

PUGET SOUND REPORT CARD FOR 2003 - 2004

The report card is a snapshot assessment for Puget Sound using the status and trend data that are covered in more detail elsewhere in the *State of the Sound 2004.*



Background: Dunlins in Boundary Bay / Mike Yip

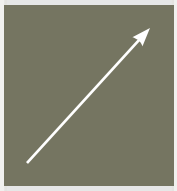
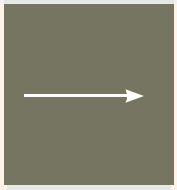
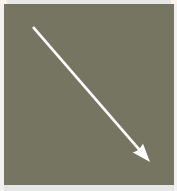
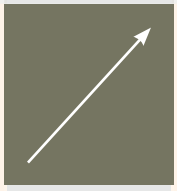
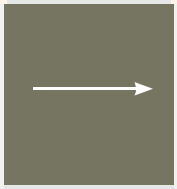
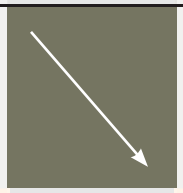
Status Rating:

Excellent:	Healthy
Good:	Some local and/or minor impairment
Fair:	Degraded conditions occur in multiple locations and/or are locally severe
Poor:	Impairments are widespread or severe in multiple locations or for multiple resources
Critical:	Damage is extensive and/or risks are substantial

Trend Rating (arrows):

Up:	Improvement
Trending up:	Some indication of improvement; improvements outweigh losses
Flat:	Improvement equally offset by losses; or holding ground
Trending down:	Some indication of decline; losses or potential losses outweigh improvements
Down:	Unequivocal decline

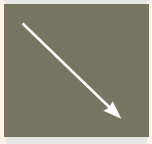
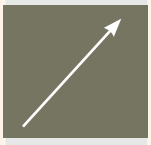
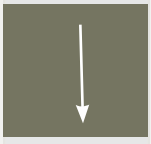
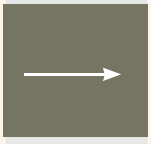
State of the Sound's Water and Submerged Lands

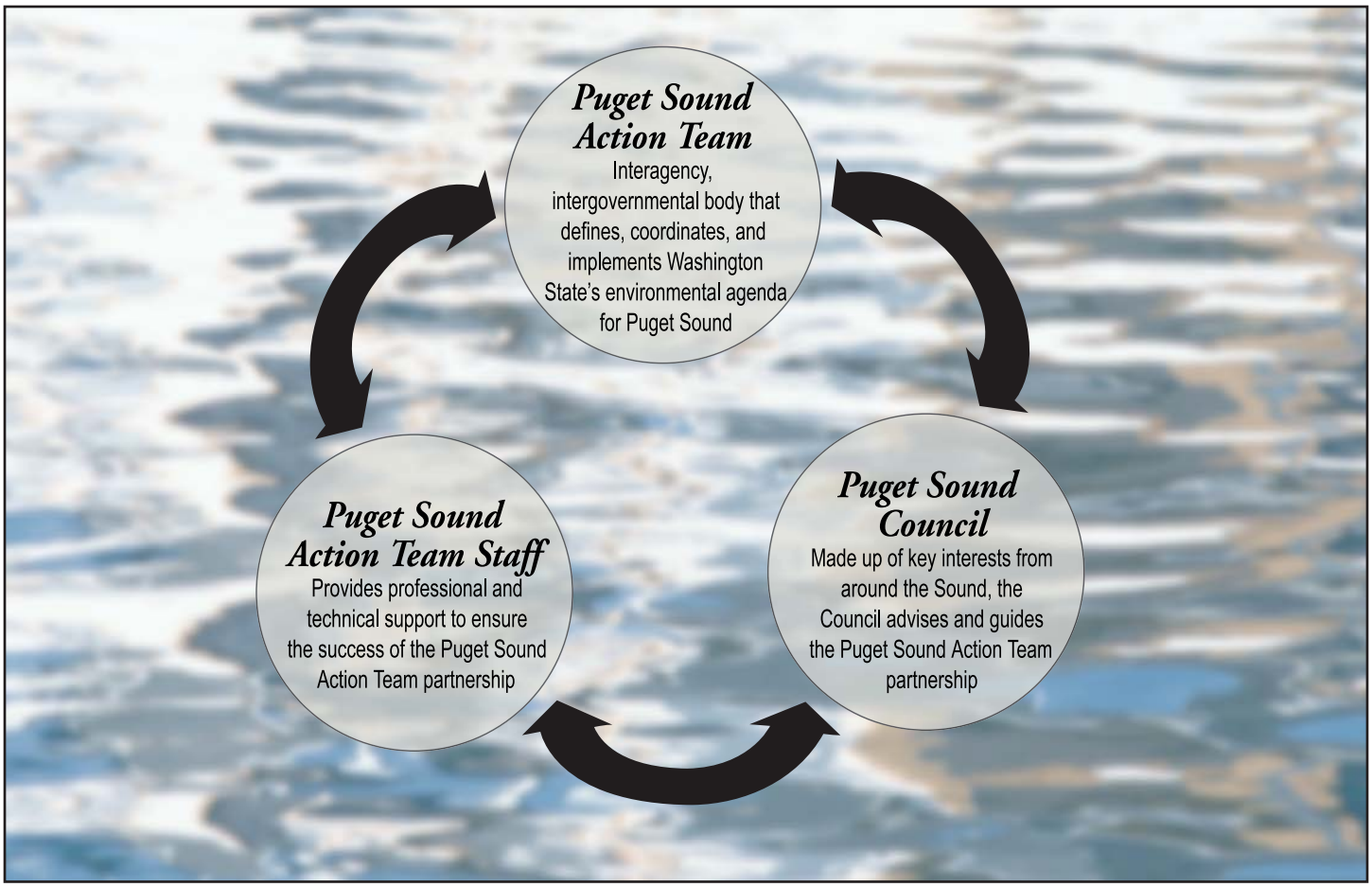
Measure	Status	Trend	
Contaminated Sediments	**Fair:** Of the Sound's 1.8 million submerged acres, 5,700 acres are highly contaminated. They are primarily found in industrial harbors. Contaminants, such as PCBs and PAHs, are among the greatest concern to organisms including orcas, seals, English sole, and mussels.		Highly contaminated sites are being cleaned up and new sites are not being created.
Polychlorinated Biphenyls (PCBs)	**Fair:** PCBs in English sole, herring, salmon, harbor seals, and orcas indicate contamination of the Puget Sound food web. PCBs in urban or industrial areas have triggered fish and shellfish consumption advisories. PCBs levels in Puget Sound chinook are three times higher than in chinook from other locations. Away from urban bays, levels of PCBs in mussel tissues are below the national average.		PCBs concentrations have declined slowly if at all in recent years.
Polycyclic Aromatic Hydrocarbons (PAHs)	**Fair:** Current levels of PAHs are associated with higher incidence of liver lesions in English sole in urban bays. PAHs in urban and industrial areas have triggered fish and shellfish consumption advisories. PAHs in Puget Sound mussel tissues are higher than elsewhere around the U.S. coast.		PAHs increased at 4 out of 10 long-term sediment monitoring stations between 1989 and 2000.
Metals (Arsenic, Copper, Lead, Mercury, Tributyltin)	**Fair:** Levels of arsenic, mercury, and tributyltin in urban and industrial areas have triggered fish and shellfish consumption advisories. Metals in Puget Sound mussel tissues are lower than elsewhere in the U.S., including on the Washington coast.		Levels of arsenic, copper, lead, and mercury have declined or remained steady in sediments and mussel tissue in the past decade.
Acres Available for Shellfish Harvest	**Fair:** In 2004, almost 135,000 acres of commercial shellfish growing areas were approved or conditionally approved for harvest. Shellfish harvest is prohibited or restricted on beaches along the entire eastern Puget Sound shoreline from Everett to Tacoma.		Net upgrade of 1,655 acres of commercial shellfish growing areas in 2003 and 2004. However, the number of shellfish growing areas placed on the threatened list has doubled from 1997 to 2004.
Stormwater Overall	**Fair:** The stormwater rating is based on a combination of indicators—impervious land cover and the effects of stormwater-related contamination on fish health.		
Impervious Land Cover	16% of the low-elevation portion of the basin draining to central Puget Sound is considered too built out to fully protect fish and wildlife habitat.		Impervious surface cover increased by more than 7% in an 8-year period in the 1990s.
Liver Lesions in English Sole	PAHs are a pollutant of concern in stormwater and are associated with higher incidence of liver disease in English sole from urban areas of the Sound. Studies indicate that heightened risk of liver lesions occurs in hot spots, but is not extensive throughout urban bays.		No trend of liver disease was evident at most locations.

State of the Sound's Habitat

Measure	Status	Trend	
Lowland Habitat Loss	**Fair:** From 1991 to 1999, about 73 square miles or 1% of the lowland area of central Puget Sound was converted from forest, grass, or cropland to land with at least 15% impervious surfaces. Newer data are not yet available.		Loss of forest is a serious threat to habitat functions provided by natural landscapes.
Eelgrass	**Incomplete:** No historical data exist to set a standard for a healthy population of eelgrass in Puget Sound. The state began monitoring eelgrass in 2000. About 50,000 acres of eelgrass beds are in Puget Sound.		Between 2002 and 2003, eelgrass declined by 4%. Of particular concern is the rapid loss of specific beds. Longer term, scientists are concerned that eelgrass has decreased, but trends are unknown due to lack of historical information.
Spartina Infestation	**Good:** The state kept this aggressive grass in check in Puget Sound.		The state has reduced spartina infestation from 1,000 acres in 1997 to 680 acres in 2004.

State of the Sound's Species

Measure	Status	Trend	
Species at Risk	**Poor:** 40 Puget Sound species are listed as threatened, endangered, or are candidates for those listings on state and federal lists.		This is a new indicator—no trend data exist yet.
Salmon	**Poor:** Populations of chinook salmon, Hood Canal summer chum, and bull trout are listed as threatened under the federal Endangered Species Act. Coho salmon in this region are on the federal list as a species of concern.		Marine survival of coho from 3 monitored streams declined to very low numbers in 1999. Since then, marine survival of coho from 2 of the streams has improved, but survival numbers in one remain low.
Rockfish	**Critical:** Some rockfish populations are at less than 10% of their historic levels.		Trend information for rockfish are not available for 2002 through 2004. Trends from earlier years show steep declines in spawning potential that may have leveled off by 2002, but this is not confirmed.
Herring	**Fair:** 3 herring stocks are in depressed or critical condition, while 15 are healthy or moderately healthy. The Cherry Point stock, once the largest in Puget Sound, is at much lower than historic levels.		Herring populations have improved since lows of 1997. Stocks classified as healthy or moderately healthy increased from 12 in 2000 to 15 in 2002. Stocks classified as depressed or critical decreased from 5 in 2000 to 3 in 2002.
Marine Birds	**Poor:** Populations of western grebes and surf scoters in 2002 are much lower than those observed in the 1970s.		Western grebes have declined by 95% and surf scoters have declined by 57% since the late 1970s.
Orcas	**Poor:** The state has listed all orcas that visit or reside in Washington waters as endangered.		The population of southern resident orcas began declining in 1996 following a steady increase for the prior decade. The decline has reversed in recent years and the population remained stable through 2003/2004.



Puget Sound Action Team Partnership's Key Accomplishments in 2003 - 2004

- Implemented a plan to reduce mercury in the environment.
- Drafted a plan to reduce polybrominated diphenyl ethers (PBDEs).
- Continued cleanup work on 530 acres of contaminated sediments.
- Designed new guidelines to manage shorelines.
- Provided resources to help local governments protect habitat through growth management plans.
- Began expanding stormwater management programs to smaller cities and most construction sites.
- Produced a technical manual about how to reduce stormwater impacts from development.
- Developed a manual of procedures to manage runoff from state highways.
- Assessed and began actions to reduce human sources of nutrients into Hood Canal.
- Achieved a net upgrade of 1,655 acres of shellfish growing areas available for harvest.
- Evaluation underway for six sites for protection under the state's aquatic reserve program.
- Aquired approximately 5,200 acres and restored 1,700 acres of marine and freshwater habitat.
- Placed orcas on the state's endangered species list with a plan underway for their recovery.
- Coordinated watershed and salmon-recovery planning throughout the Puget Sound basin.
- Secured funding for a rescue tug at Neah Bay for most of the year to prevent oil spills.
- Removed 80 acres of spartina, an invasive non-native weed.
- Produced maps of areas where forage fish spawn, to help guide decisions about land use.
- Provided $530,000 to fund 39 projects that educate and involve thousands of people in activities to protect and improve the health of the Sound.

I. State of the Sound 2004
INTRODUCTION

State of the Sound 2004 provides information about the health of Puget Sound and Washington State's work to protect it. The report will answer questions about:

- The overall health and condition of the Sound.
- Efficacy of efforts to protect and restore the Sound.
- What work remains to be done to safeguard the Sound for today, and for future generations of Washington citizens.

State of the Sound 2004 reports on the health of Puget Sound, focusing on 15 environmental indicators that provide insight into the condition of the Sound's water and submerged lands, habitats, and species, and the threats to these resources.

Since 1998, the Puget Sound Action Team has relied on indicators to communicate scientific information about Puget Sound's health, as well as to help establish work priorities and measure progress. The indicators provide insights into Puget Sound's health. They provide information about keystone species or habitat and they track conditions for which long-term trend data exist. However, indicators alone cannot tell the whole story. While indicators can help to simplify a complex, interconnected system, they are only partial windows into the Sound's condition. Other information must be used to complete the picture.

State of the Sound 2004 also reports on the progress of the Puget Sound Action Team partnership to improve Puget Sound's health in 2003 and 2004. The Action Team partnership works with federal, state, tribal and local governments, citizens, and businesses to define, coordinate, and implement Washington State's environmental agenda for Puget Sound.

State of the Sound 2004 mainly describes the work of state agencies funded by the Legislature. However, since local governments, organizations, and citizens accomplished a great deal of the progress made in Puget Sound, this report also highlights their exemplary work and innovative approaches.

State forecasters predict that 1.4 million more people will live in the Puget Sound basin by 2025. / Port of Seattle

Environmental Information About the Condition of the Puget Sound Ecosystem

The presentation of indicators of Puget Sound's health relies on data developed by many scientists working in public and private organizations. Puget Sound Ambient Monitoring Program (PSAMP) scientists developed some of the indicator information presented in *State of the Sound 2004*. PSAMP information is supplemented with results from other research and monitoring efforts.

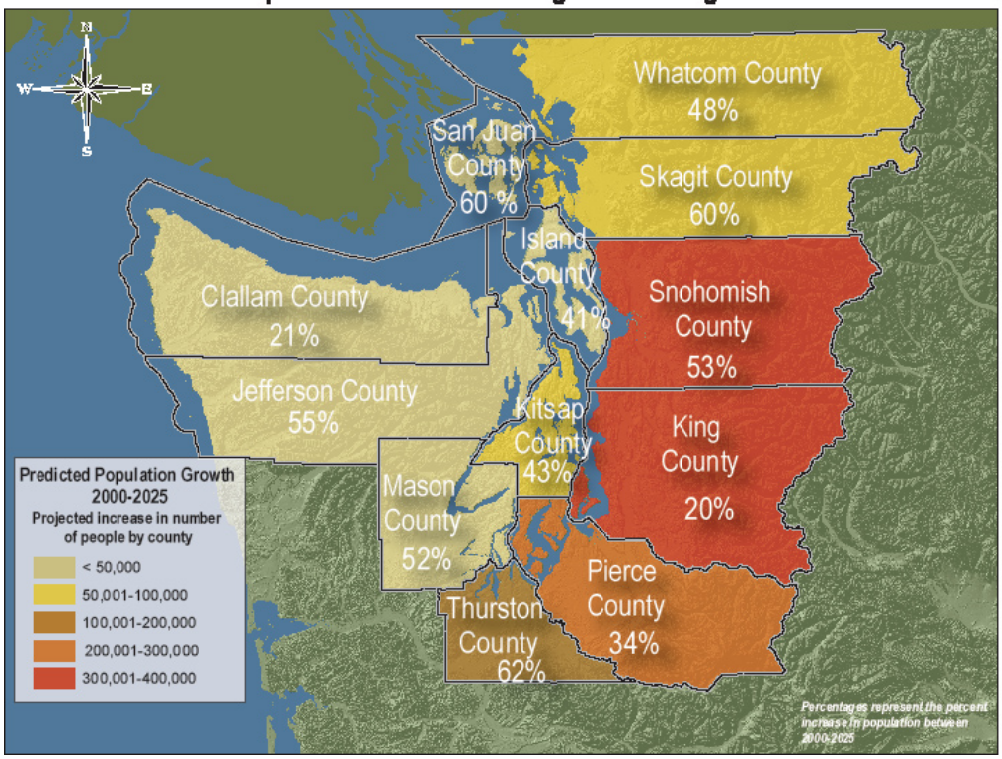
The environmental indicators presented in this document reflect the most recent data sets available in late 2004. Some indicators included in this report present status and trend information based on data reflecting conditions before 2003 or 2004. This occurs because some data are not collected every year and because of the lengthy analysis and evaluation time needed to develop some types of data.

A Population on the Rise

Of the 6 million people in Washington State, 4 million live in the 12 counties that border Puget Sound. Another 3 million live in the Georgia Basin in Canada. By 2025, experts project that more than 9 million people will live in the Puget Sound and Georgia Basin—nearly 5.4 million in the Puget Sound region and 4 million in the Georgia Basin.
Sources: Washington Office of Financial Management and BC Statistics

County	Projected Increase in Population 2000-2025
Clallam	13,570
Island	29,521
Jefferson	14,508
King	355,356
Kitsap	99,602
Mason	25,683
Pierce	241,337
San Juan	8,457
Skagit	61,818
Snohomish	323,290
Thurston	129,470
Whatcom	79,822
TOTAL	**1,382,434**

Predicted Population Growth in the Puget Sound Region: 2000-2025



Puget Sound: A Thriving Region

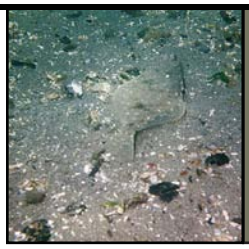
An arm of the Pacific Ocean reaches through the Strait of Juan de Fuca where the sea flows north through the San Juan Archipelago and into the Strait of Georgia in British Columbia and south through Admiralty Inlet into Hood Canal and the rest of Puget Sound. Freshwater from rivers, streams, groundwater, and runoff enters the Sound and spreads across the surface of the salt water, mixing as it flows to the Pacific.

This inland sea is one of the most productive, diverse, and beautiful ecosystems in the world. It supports 100 species of sea birds, 200 species of fish, 26 kinds of marine mammals, and thousands of invertebrate species, such as clams, crab, shrimp, sea stars, urchins, and jellyfish.

Puget Sound also supports a thriving human population. The region has a rich heritage and a promising future. The natural wealth and beauty of the lands around this inland sea continue to attract and support a vibrant economy and culture that spans the international boundary that cuts through the sea.

Puget Sound is central to the prosperity and quality of life in Washington State. The Sound's deep harbors, natural resources, and ocean ties to the Pacific Rim have spurred growth in commerce and industry and the region's development as a global trade center. The second highest volume of container traffic in the U.S. comes through the Puget Sound ports of Seattle and Tacoma. Imports and exports support nearly one-third of the state's work force. Businesses choose the region for the quality of life it offers.

Tourism, boating, kayaking, sailing, bird watching, fishing, and clamming are staples of northwest life and contribute to the economy. The state's production of farmed shellfish, much of it from Puget Sound, totals about $77 million in annual sales.[1] For centuries, the marine resources of Puget Sound and Georgia Strait have been an invaluable source of sustenance for Salish cultures in the region. Dollars cannot describe the value that a diverse, healthy ecosystem provides for all its inhabitants, human and otherwise.



II. State of the Sound's
WATER AND SUBMERGED LANDS

A. TOXIC CONTAMINATION

Thea Foss Waterway / WSDOT Aerial Photography

Many activities release toxic contamination into Puget Sound. Wastewater from sewage treatment plants and other permitted discharges flow into the Sound along with pollutants from spills; pesticide applications; illegal dumping; the tailpipes, drip pans, brake linings, and tires of cars and trucks; and from the smokestacks of factories and power plants, some as far away as Asia.

Some of these contaminants break down slowly or not at all and will continue to be toxic in the environment for decades. Those that bind to sediments or accumulate in plants and animals stay in Puget Sound, where they can kill, cause disease, and inflict chronic stress on immune and reproductive systems.

Pollutants of Concern in Puget Sound

Pollutant	Sources	Harm
Heavy Metals: Lead, mercury, copper, and others	Vehicles, batteries, paints, dyes, stormwater runoff, spills, pipes.	Exposure and ingestion can cause neurological and reproductive problems in people and animals.
Organic Compounds: Polycyclic aromatic hydrocarbons (PAHs)	Burning of petroleum; coal, oil spills, leaking underground fuel tanks, creosote, asphalt.	Can increase the risk of cancer and harm human immune systems, reproduction, and development. Associated with liver disease in English sole.
Polychlorinated biphenyls (PCBs)	Solvents, electrical coolants and lubricants, pesticides, herbicides, treated wood.	Exposure can retard growth, reduce fertility, cause birth defects, liver damage, and skin lesions in animals.
Dioxins, Furans	Byproducts of industrial processes.	Exposure is linked to cancer, liver disease, and skin lesions in humans.
Dichloro-diphenyl-trichloroethane (DDTs)	Chlorinated pesticides.	Thins bird eggshells and causes reproductive and developmental problems. DDTs are linked to cancer, liver disease, and hormone disruption in animals in laboratory tests.
Phthalates	Plastic materials, soaps, and other personal care products. Many of these compounds are in wastewater from sewage treatment plants.	The toxic effects of phthatates are not well known. Chronic exposure may affect growth in fish.
Polybrominated diphenyl ethers (PBDEs)	PBDEs are added to a wide range of textiles and plastics as a flame retardant. They easily leach from these materials and have been found throughout the environment and in human breast milk.	The effects of exposure to PBDEs are unknown, but the molecule is similar in structure to the thyroid hormone, which governs growth and reproduction.

Contaminant concentrations of some bioaccumulative chemicals increase as they go up the food chain until the pollutants may end up on dinner plates. The Washington Department of Health (DOH) and local health districts around the Sound issue fish and shellfish consumption advisories that warn people not to eat contaminated seafood. / *Michelle L. McConnell*

Fish and Shellfish Advisories for Puget Sound, as of September 2004

Body of Water County	Contaminant	Species
Dyes Inlet Kitsap County	naval ordnance	bottomfish, shellfish, crab
Eagle Harbor Kitsap County	PAHs, mercury	bottomfish, shellfish, crab
Manchester State Park Kitsap County	PCBs, dioxins	shellfish
Sinclair Inlet Kitsap County	mercury, PAHs	bottomfish, rockfish, crab
Indian Island Jefferson County	pesticides, metals	shellfish
Duwamish River King County	PCBs, mercury, PAHs, arsenic, tributyltin	bottomfish, rockfish, shellfish, crab
Lake Washington King County	PCBs, mercury	northern pikeminnow, yellow perch, cutthroat trout, bass
Puget Sound waters within King County, excluding Vashon Island	historical industrial discharges	bottomfish, shellfish, crab, seaweed
Commencement Bay Pierce County	PCBs, diethylphthalates, trichloroethylene, metals	bottomfish, shellfish
Budd Inlet Thurston County	creosote, volatile organic compounds, pentachlorophenol, dioxins	shellfish
Lake Whatcom Whatcom County	mercury	smallmouth bass, yellow perch

Source: DOH

INDICATOR: Contaminated Sediments in Puget Sound

As cities around the Sound grew and prospered, human activities left chemical contaminants buried in the sediments. Pulp mills, chemical factories, smelters, shipyards, oil refineries, and other industries dumped byproducts into the Sound for years before federal and state governments placed controls on such discharges. Most of the contaminated sediments in Puget Sound are found in the nearshore areas of urban bays near Seattle, Tacoma, Bremerton, Everett, and other major cities.

Contamination on the Move

Animals that live in polluted sediments accumulate pollutants in their tissues in concentrations that can be thousands of times higher than the surrounding water. The animals that move out of the contaminated hot spots carry the pollutants with them and transfer the toxics up the food chain to animals that eat them. Predators add to their pollutant burden with each meal of contaminated prey.

For example, chinook salmon in Puget Sound now accumulate concentrations of PCBs three times higher than chinook from other locations. Chinook salmon that spend more time in Puget Sound appear to develop higher concentrations of PCBs than chinook that spend more time in the ocean where the plankton is less contaminated.

Status

In 1997, Ecology and the National Oceanic and Atmospheric Administration (NOAA) conducted a study that classified the quality of sediments at about 300 stations throughout much of Puget Sound. The agencies based their classification system on three tests:

- Concentrations of more than 180 contaminants.
- Toxicity tests.
- Abundance and diversity of the animal populations living in the sediments.

The study indicated that 400,000 acres of the area surveyed in Puget Sound are clean. Sediments of intermediate quality cover 179,000 acres, and 5,700 are highly degraded.

Researchers detected arsenic, copper, lead, and mercury throughout the Sound. They found cadmium at 59 percent of the stations and tributylin, an antifouling chemical found in ship hull paint, at 50 percent of the stations. The highest concentrations were usually found in the urban bays. PAHs were common while phthlalate esters, PCBs, DDTs, and dibenzofurans appeared at fewer stations.

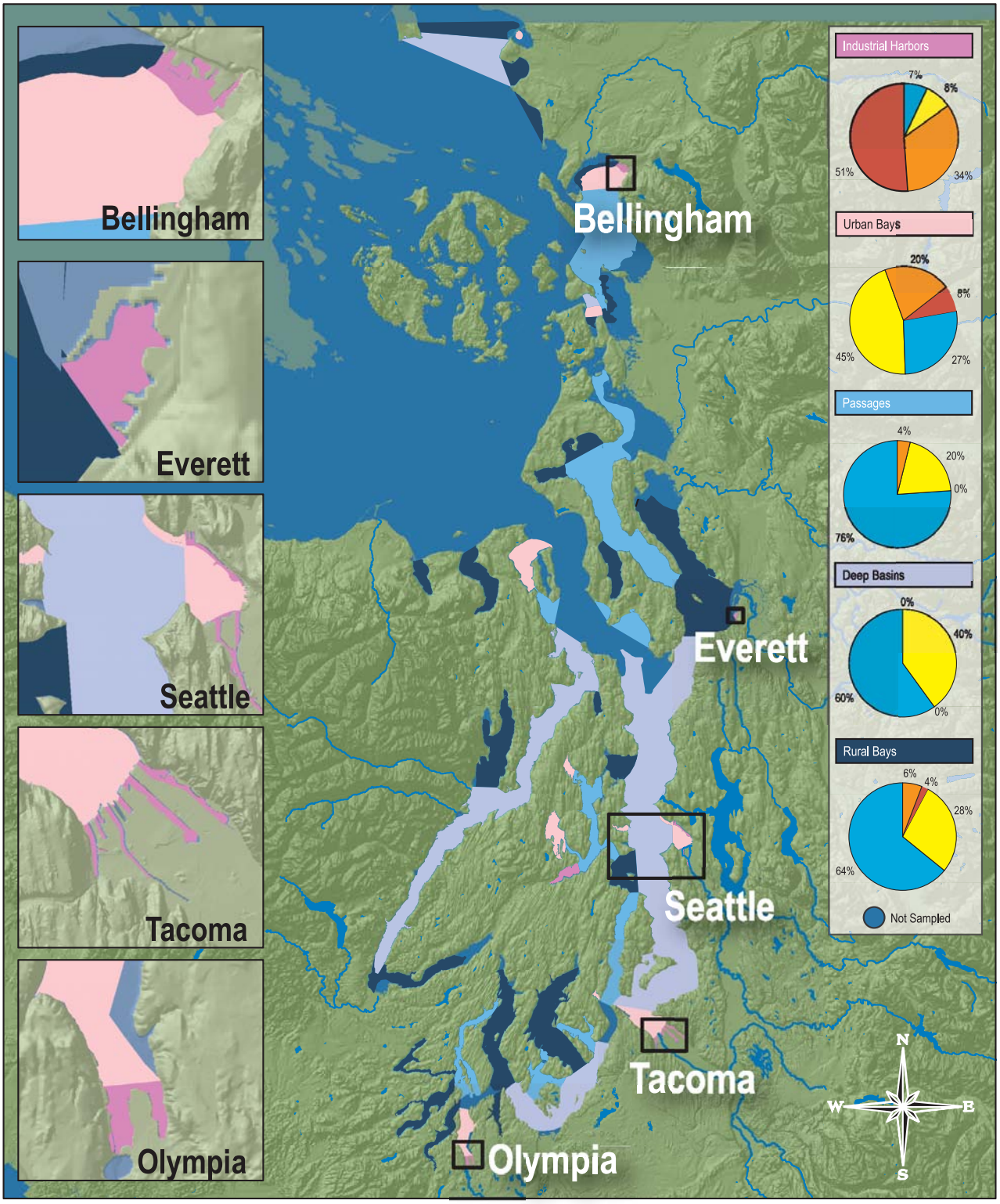
Trend

Although the highly degraded sediments comprise a small percentage of the Sound's area, these hot spots upload pollution into the food web, and the resulting damage to the ecological health and function of the Puget Sound ecosystem may be much greater than the small area suggests.

Core samples from clean pre-settlement times to the present show that contaminant levels for some chemicals peaked before the 1970s and have been steadily dropping since. Much of the contamination still present in the mud came from historic activities that federal and state laws have outlawed, controlled, or altered since the 1970s.[2]

Long-term monitoring shows mixed trends in recent years for some chemicals found in sediments. Although levels of PAHs are lower than their peak during the coal-burning era of the early 20th century, levels increased from 1989 to 2000 at four out of 10 sampling sites: Strait of Georgia, Bellingham Bay, East Anderson Island, and Inner Budd Inlet. The other six stations showed no significant change for PAHs. Mercury and copper levels are lower throughout the Sound with the exception of Sinclair Inlet, which has a higher concentration of copper than all other sites. However, levels of copper have decreased during the past 10 years at this site.

Sediment Quality in Puget Sound



Contaminated Bays and Harbors

Information collected from 1997 to 1999 indicated that about 5,700 acres of Puget Sound sediments, mostly in Puget Sound's industrial harbors and urban bays, are highly degraded. Sediment cleanups undertaken in recent years may have improved this picture. In the study from the 1990s, researchers evaluated sampling locations for degradation based on three tests—contaminant concentrations, toxicity of sediments to laboratory test organisms, and the abundance and diversity of the animals living in the sediments.

Source: Department of Ecology

High Quality
Intermediate - High Quality
Intermediate - Degraded
Degraded

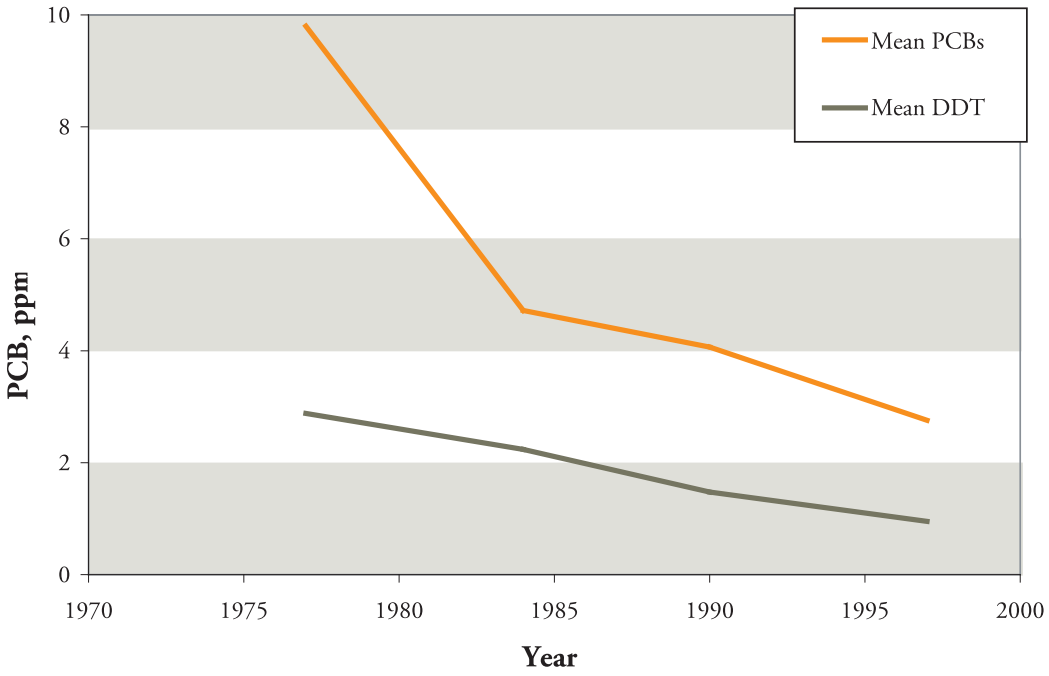
Submerged Areas Key for Sediment Quality

High quality: *no problems in any of the three tests*
Intermediate/high quality: *problem in one test*
Intermediate/degraded: *problems in two tests*
Degraded: *problem in all three tests*

INDICATOR: Contaminants in Harbor Seals

The presence of contaminants in harbor seals is another indicator of toxic contamination in Puget Sound. Even though U.S. manufacturers stopped producing DDTs and PCBs in the 1970s, both chemicals are still found in the environment because they break down slowly and they accumulate in the fat of organisms. Harbor seals are the unfortunate indicators of persistent contaminants in the Puget Sound food chain because toxins, such as PCBs and DDTs, accumulate in their abundant fat layers.

Trends in Contaminants in Harbor Seal Pups from Smith Island



Levels of PCBs have declined at Smith Island since 1975. This downward trend has slowed and PCBs have leveled off at about 5 parts per million in the blubber of harbor seal pups. This level of contamination is intermediate between the higher levels seen in southern Puget Sound and lower levels found in Georgia Basin. The levels of PCBs observed in Puget Sound harbor seals may compromise their immune systems and affect reproduction and development.
Source: Cascadia Research Collective

Status

Harbor seal pups from Smith Island in northern Puget Sound show a level of contamination that is between the levels observed in southern Puget Sound and the Strait of Georgia in British Columbia.

Trend

Levels of PCBs have declined at Smith Island since 1975, yet this downward trend has slowed and PCBs have leveled off at approximately 5 parts per million (ppm) in the blubber of harbor seal pups.

Harbor Seal / Brian Walsh

INDICATOR: Contaminants in Mussels

Mussels get their food by filtering large quantities of water. This makes them good indicators of water quality as they tend to concentrate contaminants that are present in the water. NOAA periodically tests mussels for contaminants at 13 Puget Sound stations and other sites throughout the nation.

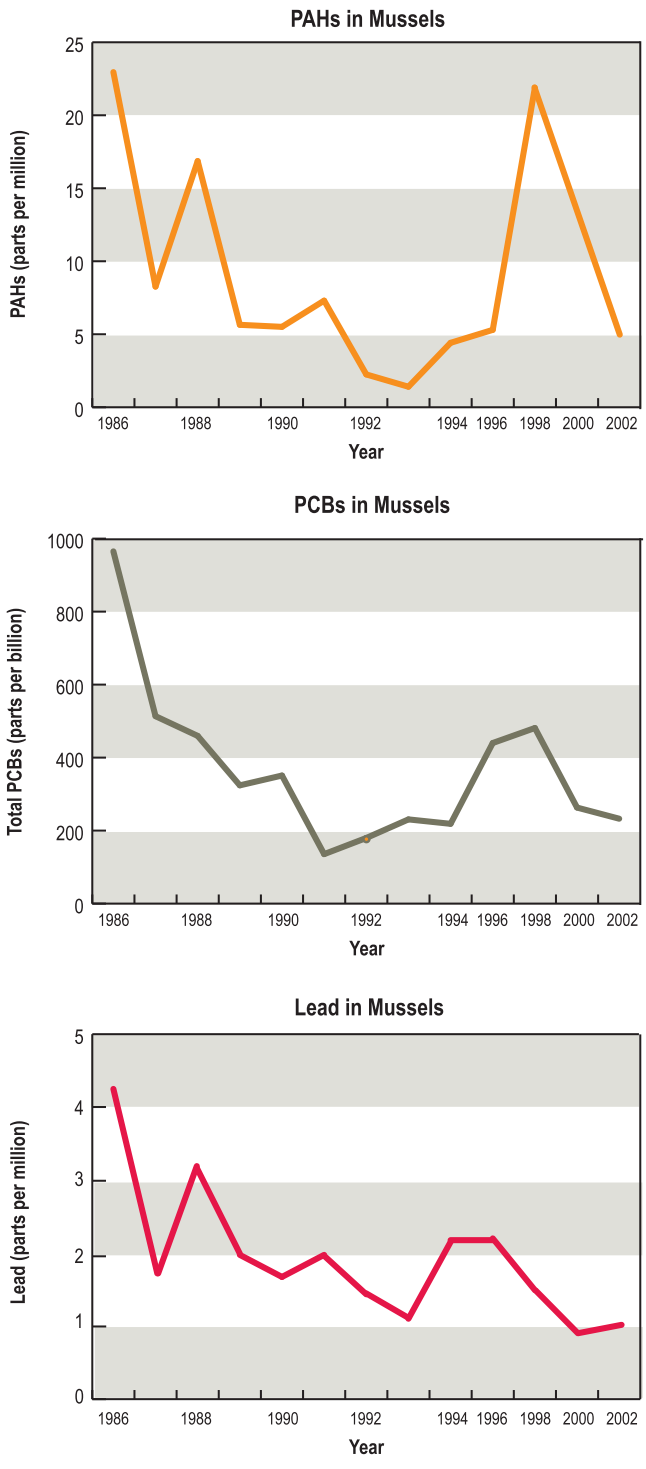
Status

Data from 1997 through 1998 show that some organic chemicals—especially PAHs—accumulated to higher concentrations in Puget Sound mussels than in mussels (and oysters) elsewhere around the United States coastline. In contrast, many metals (including arsenic, copper, lead, and silver) were present in lower concentrations in Puget Sound mussels than observed in more remote areas including the outer coast. Newer data are not available for the rest of the nation. Concentrations of PCBs from Puget Sound mussels are generally in line with nationwide levels. Within Puget Sound, PCBs concentrations in mussels are highest in Elliott Bay.

Trend

PCBs declined in the late 1980s, then increased in the early 1990s, with a peak in 1996 through 1998. PCB levels have declined since 1998. Levels of PAHs declined between 1986 and 1993, then increased dramatically between 1993 and 1998. This peak was followed by a steep decline. Mercury and lead decreased between 1986 and 1994, then increased until 1998, and they've declined ever since.

Toxic Contamination in Mussels from Elliott Bay



A generally declining trend in contamination of mussels from Elliott Bay was interrupted during the late 1990s, possibly because contaminants were released to the waters of the bay during construction activities along the Seattle waterfront. Contaminant trends at 12 other mussel watch monitoring locations in Puget Sound have not yet been analyzed, but based on results in prior years, could be different from those seen in Elliott Bay.
Source: NOAA

INDICATOR: Liver Lesions in English Sole

PSAMP staff monitor the contaminant levels and occurrence of liver lesions in tissues of English sole at more than 40 sites in Puget Sound. Sole are a good indicator of sediment quality because they are bottom dwellers and they eat animals in the sediment. English sole accumulate arsenic, lead, PCBs, and PAHs.

Risk of English Sole Developing Liver Disease in Elliott Bay

Researchers study English sole to gather information about sediment quality. / Steve Quinnell

English sole that live close to the heavily industrialized areas of Elliott Bay have 24 times the risk of developing liver disease compared to fish from rural areas of Puget Sound. English sole from other areas around Elliott Bay show elevated, but lower levels of liver disease. Fish from Alki Point, just outside the bay, have the same risk of liver disease as fish from rural locations. Source: WDFW

Status

Liver lesions are found most frequently in English sole living in the contaminated sediments of urban bays. Studies show that although the risk of developing liver lesions increases with fish age, exposure to contaminated sediments, particularly sediments laced with PAHs, is the main risk factor. PAHs in Puget Sound's urban waterways appear to pose an ongoing threat to the health of English sole and may be affecting other organisms.

Trend

Trends in liver disease at most of the PSAMP long-term monitoring sites have fluctuated through the years. The incidence of liver disease increased in English sole tested along the Seattle waterfront between 1989 and 1998, but decreased in 1999 and was low again in 2000[3]. Liver disease declined along the Seattle waterfront and in Eagle Harbor after contaminated sediments were capped with clean sediments in the late 1980s and mid-1990s.

The Partnership's Work to Clean up and Prevent Toxic Contamination

The Action Team partnership's goal is to reduce pollutants so that they no longer cause harm to marine life or pose a risk to human health. The Action Team partnership does this by cleaning up contaminated sediments, controlling pollution sources, preventing oil spills, and educating people about pollution prevention.

Cleaning up Contaminated Sediments

Ecology and the U.S. Environmental Protection Agency (EPA) oversee cleanups of contaminated sediments. They rank contaminated sites in Puget Sound according to the risk they pose to human and environmental health, and direct cleanup strategies for sites that pose the greatest risks. Ecology established sediment management standards for Puget Sound in 1991, and maintains an ongoing database of contaminated sites.

Dredging contaminated sediments for upland disposal. / *Department of Ecology*

Of the 1.8 million acres of aquatic lands in Puget Sound:

- Ecology has surveyed 15,240 acres for contamination. In 2004, Ecology determined the level of contamination and eligibility for cleanup, or source control for 4,516 acres of sediments.
- 5,748 acres exceed sediment management standards. About 2,874 acres in 110 sites exceed sediment cleanup standards and have triggered the cleanup process.
- Nearly two-thirds of those sites are being scoped for cleanup or are in the process of being cleaned up.
- Half the contaminated acres that exceed sediment management standards are not slated for cleanup, because Ecology expects they will recover through natural processes.

State and federal agencies are working with responsible parties to clean up 530 acres of contaminated sediments in Puget Sound:

- 140 acres in Commencement Bay.
- 70 acres in Elliott Bay and the Duwamish Waterway.
- 80 acres in Eagle Harbor.
- 240 acres in Sinclair Inlet.

State and federal agencies are working with responsible parties to clean up 530 acres of contaminated sediments in Puget Sound.

Identifying and Cleaning up Water Quality Problems

In addition to sediment contamination, toxic chemicals cause water quality problems in Puget Sound. Every two years, the federal Clean Water Act requires states to prepare a list of water bodies that do not meet state water quality standards. Ecology compiles and assesses water quality data to understand the condition of Washington's waters.

In November 2004, Ecology published its 2002/2004 draft water quality assessment for comment. The number of water quality problems in Washington State increased from 2,362 in 1998 to 2,617 in 2004. The draft 2002/2004 list identifies 1,321 water quality problems in the Puget Sound Basin. This is a slight decrease from the 1,487 problems identified in 1998, reflecting both improvements in water quality and completion of activities from water cleanup plans.

Ecology must develop a Total Maximum Daily Load (TMDL) or water cleanup plans for each water body on the list. The TMDL includes a technical assessment of the problem, analysis of the pollution reduction needed to meet water quality standards, and a plan to manage the pollution and monitor the effectiveness of the cleanup. Ecology works with local communities to develop and implement the cleanup plans.

Preventing Future Contamination

Cleaning up toxic sites and polluted waters only works when sources of pollution are eliminated to prevent recontamination. As sites are cleaned up and sources of contamination removed, the amount of toxic pollution coming into Puget Sound from identifiable point sources should decrease. The Action Team partnership's strategy for pollution prevention includes:

- Using source control methods on identifiable problems. Source control works best where discharges can be traced to a pipe or a point of origin. Nonpoint sources such as stormwater that can't be traced to a single origin, are much more difficult to control. (Stormwater management is described in more detail on page 23 of this report.)

- Eliminating the use and release of persistent bioaccumulative toxic (PBT) chemicals. Ecology monitors PBTs, eliminates sources, cleans up PBTs, prevents contamination from new sources, and educates people about the threats posed by these chemicals. To date, a mercury plan has been adopted and a draft plan for PBDEs has been released.

- Managing less contaminated sites by controlling sources and allowing clean sediments to bury the pollutant over time. As clean new sediments naturally settle to the bottom of the Sound, they will bury the toxins to depths beyond the reach of marine organisms. Some toxins will eventually break down in the environment.

Water Quality Problems in the Puget Sound Basin

Cause	Number of Problems	Percent of Total Problems
Fecal Coliform Bacteria	541	41
Temperature	268	20
Dissolved Oxygen	264	20
pH	61	5
Total PCBs	35	3
Mercury	11	1
Other	141	10
Total	**1,321**	

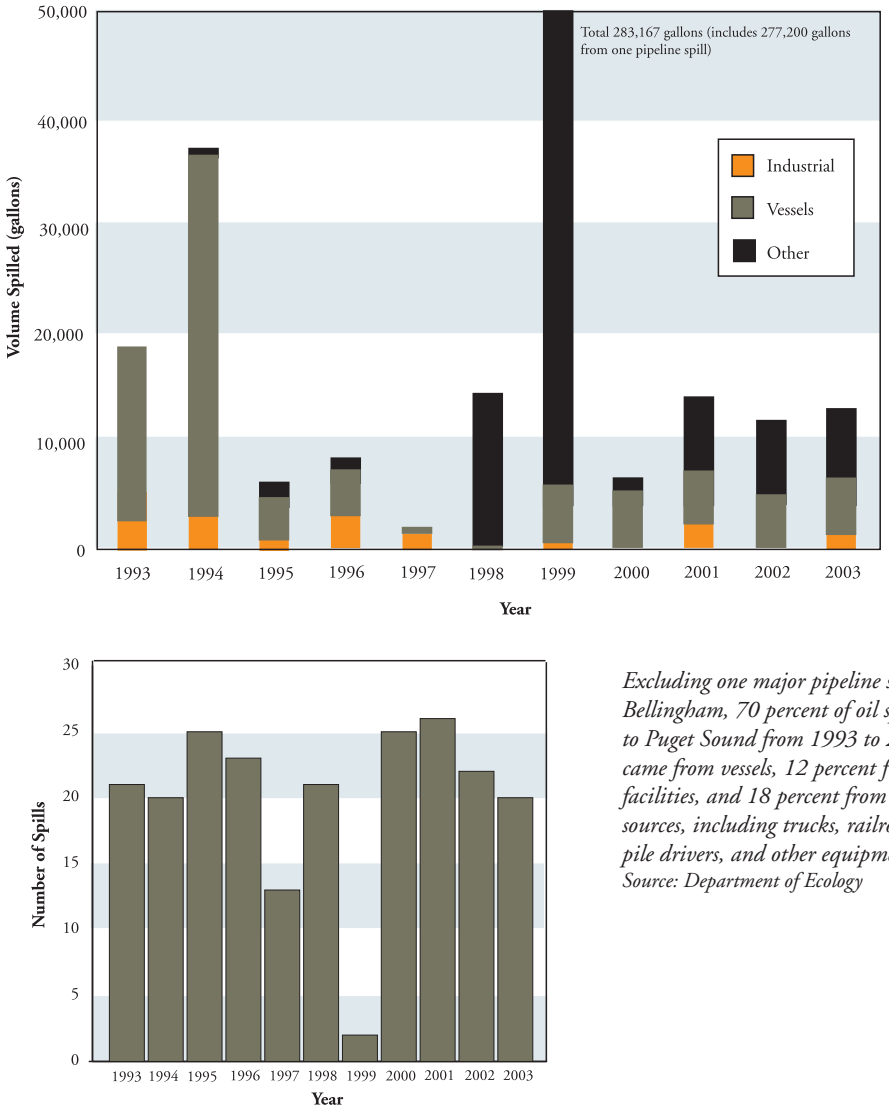
Oil Spills

Oil spills are a serious pollution threat in Puget Sound. Each year, vessels transport about 15 billion gallons of crude oil and refined petroleum products through Puget Sound, and shipments are expected to increase in the future. Large quantities of oil, gasoline, and other fuels also travel through the region's pipelines. Marine terminals, where oil is transferred between ships and land, and highway transportation by tanker trucks also contribute to the risk of major spills. Fuel spills can devastate marine life.

Ships are also a source of fuel spills in Puget Sound. The Strait of Juan de Fuca, Georgia Strait, and Puget Sound are major transportation corridors. Every day dozens of large cargo ships, tankers, and oil barges travel through Puget Sound and the Georgia Strait.

Between 1993 and 2003, the Puget Sound basin suffered spills of more than 418,500 gallons of oil.

Numbers and Volumes of Oil Spills from Vessels, Facilities, and Other Sources, 1993-2003



Excluding one major pipeline spill in Bellingham, 70 percent of oil spilled to Puget Sound from 1993 to 2003 came from vessels, 12 percent from facilities, and 18 percent from other sources, including trucks, railroads, pile drivers, and other equipment.
Source: Department of Ecology

Two Serious Spills in 2003-2004

In late December 2003, while Foss Maritime staff were filling a barge with bunker fuel at Point Wells, near Edmonds, 4,800 gallons of oil streamed into the water. Winds and currents pushed the spill across the Sound to Kitsap County where it washed up on beaches rich with marine life. The spill polluted a tidal marsh and shellfish beds owned by the Suquamish Tribe and publicly owned aquatic lands managed by the Washington Department of Natural Resources (DNR). The cleanup lasted 16 weeks. In some places, crews hand-scrubbed rocks on cobble beaches.

Another spill occurred on October 14, 2004, when an unknown vessel spilled an estimated 1,000 gallons of oil into Dalco Passage, between Tacoma and Vashon Island. The spill left a filmy coating along six miles of southern Vashon and Maury islands and spread patches of oily sheen along 15 miles of Colvos Passage, Tacoma Narrows, and Quartermaster Harbor. Crews recovered an estimated 59 tons of oily debris from shoreline cleanup and skimmed 6,842 gallons of oily water at a cost of nearly $2 million.

These two serious spills illustrate the potential destruction a major spill could cause in Puget Sound. A major spill could damage a huge area of the Sound and have astronomical cleanup costs.

The state classifies two kinds of oil spills: major (10,000 gallons or more) and serious (25 to 10,000 gallons).

Major spills: The number of major spills in Puget Sound has gone down since the Exxon Valdez spill in Alaska in 1989, when responders moved from a reactive to a proactive approach to oil spills. The last major spill in Puget Sound occurred in 1999 when 277,200 gallons of gasoline spilled from a pipeline rupture at Whatcom Creek in Bellingham.

Serious spills: Between 1993 and 2003, 223 serious spills released 114,405 gallons of oil into Puget Sound.

Preventing Oil Spills

Since the state debuted its oil spill program in 1991, responders have seen a dramatic decrease in major spills of 10,000 gallons or more.

- Ecology works with the U.S. Coast Guard and industry partners to prevent spills through training, inspections of oil-handling facilities and vessels, approval of spill plans, and emergency drills.

- The agency screens more than 2,600 cargo and passenger vessels each year to promote safe operation and maintenance.

- In response to the Point Wells spill, the 2004 Legislature passed a bill aiming for zero oil spills. The law directed Ecology to provide recommendations for safer oil-transfer rules by the end of 2004, and by 2006, guidelines for the use of containment booms during oil transfers.

- Washington Sea Grant program (Sea Grant) educates boat owners about preventing oil spills. In 2003 and 2004, Sea Grant held five workshops for U.S. Coast Guard Auxiliary personnel, explored ways to adopt spill prevention standards in marinas, educated commercial fishing boat operators, distributed hundreds of spill prevention kits, and placed spill prevention tips in the Marine Yellow Pages, a directory used by vessel operators and marine industry representatives.

Rescue Tug Extended at Neah Bay
Vessels were responsible for 70 percent of the oil spilled in Puget Sound between 1993 and 2003. To reduce this risk, since 1999, a rescue tug has been stationed at Neah Bay for the nearly 10,000 tankers and cargo ships that travel through the strait each year. The tug assists distressed ships off the outer coast and in the Strait of Juan de Fuca. The 2003 Legislature allocated funds to extend the number of days that assistance was made available to vessels. During the 2003-2004 season, the tug operated 236 days. Between 1999 and October 2004, the tug answered 24 distress calls. / *Department of Ecology*

Cleanup Success Stories

Fifty-seven Pounds per Acre of PCBs Removed
In March 2004, King County completed a seven-acre cleanup in the Duwamish Waterway at Diagonal Way at an old combined sewer overflow site. The county removed 66,000 cubic yards of sediments laced with nearly 400 pounds of PCBs—that's 57 pounds of PCBs removed per acre.

Cleaning up Commencement Bay
Twenty years ago, EPA designated 12 square miles of the heavily industrialized Commencement Bay tideflats as one of the 10 highest priority Superfund sites in the nation. Federal, state, and local cleanup efforts have removed more than 1.3 million cubic yards of contaminated sediments from the Sitcum, Thea Foss, Middle, and Hylebos waterways. An additional 1.6 million cubic yards are being removed in on-going cleanups. To date, more than 20 acres have been capped with clean sediments and 33 acres have been restored for habitat.[4]

More than 30 years after the passage of the Clean Water Act, a great deal of work remains to keep pollutants out of Puget Sound.

Continuing Challenges with Toxic Contamination

Five thousand acres of highly contaminated sediments and 1,321 water quality problems in the Puget Sound basin are evidence that the federal Clean Water Act goals of fishable and swimmable waters have not yet been met in Washington State. More than 30 years after passage of the act, the Action Team partnership, municipalities, businesses, and citizens that release pollutants to the environment still have a great deal of work to do to keep those pollutants from entering Puget Sound.

- Cleaning up the Sound's contaminated sediments is slow and expensive and the primary challenge is finding ways to pay for the cleanups. With federal Superfund money woefully inadequate to the task, and public ownership of 30 percent of the tidelands in Washington, determining financial responsibility for cleaning up orphan sites is an ongoing problem.
- While efforts to control some of the worst pollutants have reduced pollution in the upper layers of sediments, the toxic input to Puget Sound continues. Millions of gallons of permitted wastewater discharges pour into the Sound every day carrying a chemical mix of cleaning products, antibiotics, hormones, pharmaceuticals, personal care products, plastics, and flame retardants from millions of households, institutions, and businesses.
- Little is known about how many of these new compounds may affect human health or marine organisms. More research is needed to understand how these emerging pollutants affect the health of Puget Sound's food web, and to identify the actions that can most effectively remove toxic chemicals from the ecosystem.

B. NUTRIENTS AND PATHOGENS

Toxic contaminants aren't the only pollutants threatening Puget Sound marine life. Nutrients and pathogens also take their toll. Nutrients, such as nitrogen and phosphorus, are essential for life, but when too many of them are released into aquatic ecosystems, they stimulate algae growth. When algae die and settle to the bottom to decay, they deplete the oxygen in the water. Organic matter high in carbon can also pull oxygen from the water.

Sources of nutrients in Puget Sound include treated and untreated waste from onsite sewage systems and sewage treatment plants, discharges from boaters and other recreational activities, waste from farm animals and pets, fertilizers, stormwater runoff, and wood waste.

The problem of low dissolved oxygen plagues water bodies throughout the world and is now a critical concern in Puget Sound. Marine organisms living in low-oxygen zones become stressed, are driven out of their habitat, or die. Nutrients from human activities can lead to low levels of dissolved oxygen in sensitive areas. Some of those sensitive areas are in parts of the Sound that do not exchange water with the open ocean frequently. This contributes to the low levels of dissolved oxygen in Hood Canal, Penn Cove, and Budd Inlet.

Bacteria, viruses, and other disease-causing microbes or pathogens come from human and animal waste. Poorly functioning septic systems are a common source of pathogens in Puget Sound. Pathogens on polluted beaches can make people sick where people harvest shellfish or swim. Ecology, DOH, and local health districts issued 12 advisories in 2003 and 2004 because of bacterial pollution on Puget Sound beaches.

Fish Kills in Hood Canal

In fall 2003, visitors to Potlatch State Park on Hood Canal found a disturbing sight—more than 50,000 perch lay dead on the beach. They suffocated because sections of southern Hood Canal were nearly depleted of oxygen.

Hood Canal has a history of low dissolved oxygen levels, and in recent years the problem has worsened. The canal's long, narrow shape with a sill on the northern end and stagnant, layered waters resist mixing by tides and winds. People contribute to the problem by adding between 100 to 300 tons of nitrogen into the canal every year from fertilizers, sewage, animal manure, stormwater runoff, and decaying fish carcasses from tribal fisheries.

Fish kill in Hood Canal. / John G. Denison

Beautiful Hood Canal is plagued by low levels of oxygen. / Don Paulson

INDICATOR: Safe, Edible Shellfish

Clean water is the lifeblood of shellfish in Puget Sound. They filter large quantities of water as they feed and can also accumulate bacteria, viruses, and other contaminants. Safe, edible clams, oysters, and other bivalve shellfish are evidence of good water quality. Contaminated shellfish reflect water quality problems and can harm the people and animals that eat them.

Status

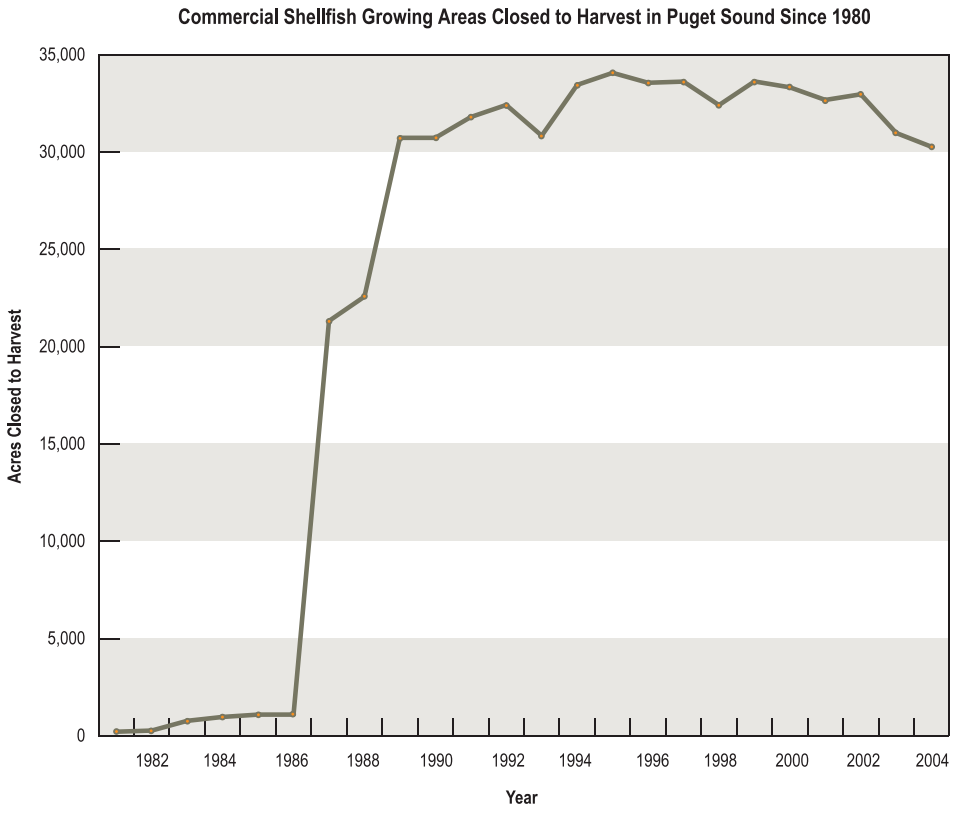
In 2004, DOH approved or conditionally approved nearly 135,000 acres of commercial shellfish growing areas for harvest. In 2003 and 2004, a net gain of 1,655 shellfish growing acres is testimony to the hard work of the businesseses, agencies, and citizen groups that have fought to clean up pollution and keep beds open in Puget Sound.

Classification of Shellfish Growing Areas
DOH monitors and classifies commercial shellfish growing areas to ensure shellfish are safe to eat and to detect pollution threats before they are severe enough to close beds.

Approved: No restrictions are placed on harvest due to contamination or sanitary conditions.
Conditionally Approved: Shellfish can be harvested and marketed only during prescribed periods. For example, a growing area may be approved during dry weather, but temporarily closed after rainfall.
Restricted: Shellfish cannot be marketed directly due to contamination. Shellfish can be moved to clean waters for a period of time to flush contaminants prior to harvest and marketing.
Prohibited: Shellfish cannot be harvested due to contamination that poses a health risk to consumers.

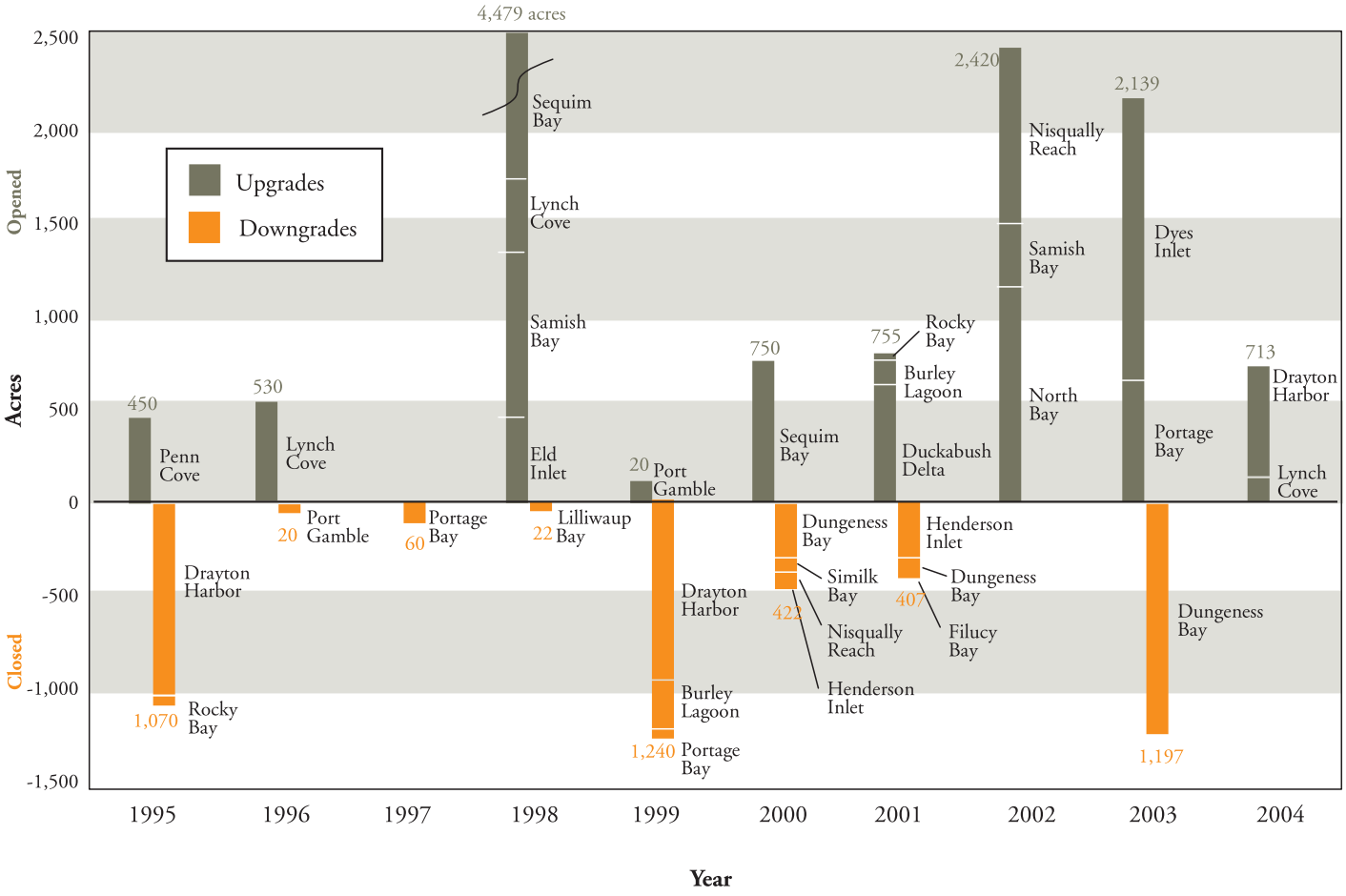
Trend

- From 1995 to mid-2004, DOH reclassifications of shellfish growing areas resulted in the downgrade of about 4,600 acres and the upgrade of nearly 12,400 acres, for a net upgrade of more than 7,800 acres.
- However, the list of shellfish growing areas threatened with closure due to pollution has grown from nine sites in 1997 to 18 sites in 2004.
- Since 1980, DOH downgraded nearly 20 percent (30,000 acres) of the area once available for commercial shellfish harvest in Puget Sound, because of bacterial contamination.



Since 1980, 30,000 acres of commercial shellfish growing areas have been closed to harvest because of pollution. Most of these closures occurred more than a decade ago. In recent years, the commercial acreage open for harvest has remained fairly steady. Source: Department of Health

Puget Sound Commercial Shellfish Reclassifications Due to Sanitary Conditions



Between 1995 and 2004, 12,400 acres of commercial shellfish areas have been upgraded and 4,600 acres have been downgraded, resulting in a net upgrade of 7,800 acres since 1995. Source: Department of Health

Geoducks on publicly owned lands are a valuable resource managed by DNR, Washington Department of Fish and Wildlife (WDFW), and the Puget Sound treaty tribes. Between 1992 and 2001, geoduck sales on state lands earned $64.7 million dollars for the state of Washington. Income from the harvest funds several programs that protect Puget Sound habitat. About 25 percent of the geoducks on publicly owned, commercial tracts cannot be harvested because they are near wastewater outfalls, marinas, or other sources of pollution.

Commercial growers put geoducks in tubes to protect the clams from predators. The quarter-inch clams will grow to two pounds when harvested. / Bill Dewey

The Partnership's Work to Manage Nutrients and Pathogens

The Action Team partnership's goal is to reduce nutrient and pathogen pollution from human and animal waste to meet water quality standards in all Puget Sound waters by:

- Developing cleanup plans to reduce sources of nutrients and pathogens.
- Managing onsite sewage systems and animal waste to prevent pollution.
- Educating citizens about ways to prevent nutrient and pathogen pollution.
- Strengthening monitoring, improving data management, and focusing corrective actions and public education in high-risk locations.

The Action Team partnership works on several levels to reduce threats from pathogens and excess nutrients. Ecology monitors the operation of about 100 wastewater treatment facilities and administers permits for local stormwater programs in the Puget Sound basin. DOH regulates large onsite sewage systems and helps local health districts manage smaller systems. Conservation districts (CDs) provide education, and financial and technical support to help landowners use best management practices to protect the environment.

Reducing Nutrients in Hood Canal

In May 2004, Action Team staff and the Hood Canal Coordinating Council issued a report that identified the human sources of nutrients entering Hood Canal, and recommended actions to reduce those sources.

In fall 2004, the Action Team partnership awarded nearly $800,000 in state and federal funds for projects to reduce nutrients in Hood Canal. The projects will keep nitrogen from onsite sewage systems, animal waste, rotting chum carcasses, fertilizer use, and other gardening practices out of the canal. Some of the projects are researching and piloting innovative methods to reduce nutrients.

In addition to controlling nutrient sources, state agencies, academic institutions, local and tribal governments, and community groups are monitoring and modeling conditions in Hood Canal during a three-year period to better understand how much of the low-oxygen levels are caused by humans.

While Hood Canal is the most severe case of oxygen-depleted waters in Puget Sound, lessons learned from the canal will be valuable for other areas that have shown low oxygen levels, such as Budd Inlet and Penn Cove.

Cleaning up Pathogens

Ecology maintains a list of water bodies in the state that have pollution problems and is responsible for developing cleanup plans for them. Fecal coliform bacteria cause 41 percent of the water quality problems in the Puget Sound basin. While most fecal coliform bacteria do not cause disease themselves, they are a red flag that other disease-causing organisms are present, and they trigger closure of shellfish growing areas. In 2004, Ecology, along with local partners developed nine water cleanup plans for fecal coliform in the Puget Sound basin.

In fall 2004, the Action Team partnership awarded nearly $800,000 in state and federal funds for projects to reduce nutrients in Hood Canal.

Controlling Pollution from Onsite Sewage Systems

The approximately 472,000 septic systems in the Puget Sound basin are a major source of pathogens. The Action Team partnership is concerned that many of the systems are old and/or poorly maintained. Failing onsite systems can foul Puget Sound with untreated sewage and pathogens. Even when working properly, typical systems do little to reduce nitrogen from human waste. Onsite systems that treat nitrogen along with pathogens are needed where excessive nutrients are linked to low dissolved oxygen levels in the water, such as Hood Canal.

DOH creates policies, standards, and technical guidance for the design and performance of onsite sewage systems and

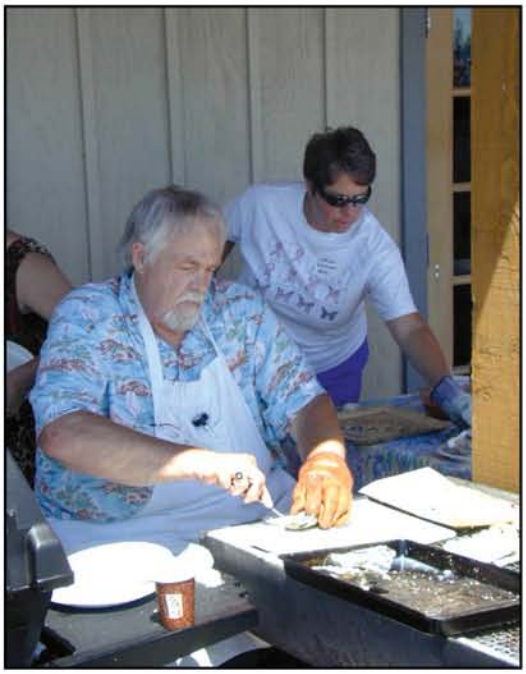
helps local health jurisdictions, businesses, and citizens comply with them. Since February 2002, DOH has been working with an advisory committee to revise state administrative rules for household-scale onsite sewage systems with capacities up to 3,500 gallons of sewage per day. The State Board of Health is scheduled to hold a public hearing on the draft rule revision in March 2005.

If the revisions are adopted, local health officials in counties with marine shorelines will be required to set priorities to manage and regulate efforts based on the degree of risk to human health posed by the use of onsite systems. The rules would also strengthen design, construction, and operation requirements.

A second committee began work in 2004 to revise rules for large onsite sewage systems with capacities above 3,500 gallons per day.

Protecting Shellfish Beds With an Early Warning System

Diligence and hard work have kept most shellfish-bed closures at bay in recent years. DOH's early warning system plays a central role in this work. Each year, the agency reviews pollution conditions in commercial shellfish growing areas and issues a list of areas that are in danger of closure. Government and tribal agencies, businesses, and organizations then use the list to correct pollution problems before closures become necessary. While they have achieved notable upgrades, the list of shellfish growing areas on the brink of closure has grown from nine sites in 1997 to 18 in 2004.



Drayton Harbor citizens celebrated their first crop of oysters from recently reopened beds at a community oyster feed.

Shellfish Success Stories

Portage Bay, Whatcom County
Upgraded in October 2003
Better management of sewage, stormwater runoff, and, most notably, dairy waste from the 100-plus dairies in the lower Nooksack Watershed led to reopening of 650 acres. Agencies and citizens reinforced the value of collaborative planning, monitoring, and action for achieving results.

Dyes Inlet, Kitsap County
Upgraded in November 2003
For the first time in 35 years, shellfish harvest resumed under a conditional classification on 1,500 acres in Dyes Inlet. Project partners repaired failing onsite sewage systems and reduced overflows from the city of Bremerton's combined stormwater/wastewater collection system.

Lynch Cove, Mason County
Upgraded in February 2004
Nearly 10 years of intensive monitoring and innovative dye studies helped Mason County identify and repair many failing sewage systems in the area. Washington State Parks and Recreation Commission replaced failing drain fields at Belfair State Park with a new treatment system. This work and other repairs helped re-open 138 acres of shellfish growing areas near the park.

Drayton Harbor, Whatcom County
Upgraded in June 2004
Citizens and agencies controlled numerous pollution sources to protect the region's first community shellfish farm. The 575-acre upgrade allowed citizen farmers to sell their first oyster crop. The profits will be reinvested to produce another crop and improve water quality.

Continuing Challenges with Nutrients and Pathogens

Around the world, waters are being overloaded with nitrates and marine and freshwater dead zones are proliferating. More areas of Puget Sound are suffering from this growing environmental challenge.

- Although sewage treatment plants have improved their treatment processes, some nutrients are still discharged to Puget Sound. As population increases, the loadings of nutrients from sewage treatment plants will increase. This can be offset by improved treatment and creating alternatives to marine outfalls. Solutions include waste water reclamation and reuse, and land application.

- Decisions to allow discharge of nutrients to Puget Sound must take into account a local marine area's sensitivity to nutrient harm. Areas of Puget Sound known to be sensitive to low dissolved oxygen levels must be managed to avoid nutrient loading.

- In spite of overall upgrades in shellfish harvest acreage, the list of threatened growing areas has doubled since 1997. Protecting shellfish resources from the pollution impacts of population growth and development requires better management of human and animal wastes, and of stormwater runoff.

- The State Board of Health lacks clear authority to regulate onsite systems to protect the environment. This lack of clear authority places the burden on other agencies, such as Ecology, the Department of Community, Trade and Economic Development (CTED), and local governments, to regulate the environmental impacts of onsite sewage systems. Legislative action could integrate authorities to achieve a coordinated regulatory program that protects human and environmental health.

Protecting shellfish resources requires better management of human and animal wastes and stormwater runoff.

C. STORMWATER RUNOFF

Ecology estimates that more than 30 percent of the state waters that fail to meet the state water quality standards are polluted because of stormwater runoff. Stormwater picks up oil, grease, metals, yard and garden chemicals, dirt, bacteria, nutrients, and other pollutants from paved areas, and carries them to streams, rivers, wetlands, and Puget Sound without treatment.

Stormwater runoff also damages fish and wildlife habitat. When rain falls on a mature forest in the Pacific Northwest, most of the water evaporates, soaks into the ground, or is taken up by vegetation. Less than 1 percent becomes surface runoff. When forests are cleared and soil is stripped, compacted and covered with roads, roofs, and pavement, the amount of surface runoff skyrockets to 30 percent or more. The landscape's capacity to absorb, infiltrate, store, and slowly release water is greatly reduced.

In this way, urban development significantly alters natural stream flows, causing higher peak flows immediately after storms, and lower stream flows during the dry season. The harm to fish and wildlife can be devastating. Too much water undercuts stream channels, delivers excessive amounts of sediment to streams, and scours stream habitat. Low summer flows and loss of trees to shade the water can lead to water temperatures that are too high for salmon or stream flows that are inadequate for fish migration. Federal agencies identified habitat loss from stormwater runoff as one of the primary obstacles to salmon recovery.

Stormwater runoff can undercut stream channels, deliver excessive amounts of sediment to streams, and scour stream habitat. / Curtis Hinman

Stormwater picks up oil, grease, metals, yard and garden chemicals, dirt, bacteria, nutrients, and other pollutants from paved areas, and carries them to Puget Sound without treatment.

INDICATOR: Land Cover Changes

When pavement, roofs, and other hard surfaces replace forests, meadows, and other natural areas they generate stormwater runoff. To understand landscape changes in the Puget Sound Basin, the Action Team staff hired the University of Washington Urban Ecology Research Laboratory to use satellite images to assess changes in the Puget Sound region between 1991 and 1999. During that time, forest cover decreased 8.5 percent. More than 6 percent was highly developed with greater than 75 percent impervious cover.

Moderate levels of development that result in 10 to 25 percent impervious land cover harm aquatic habitats, including shellfish growing areas, and the damage increases as development intensifies.[5] Shellfish waters can be harmed at even lower levels of development if the polluted runoff flows directly to the shellfish waters.

More than a century of development along Puget Sound's heavily populated eastern shore, from Everett to Tacoma, has essentially eliminated the opportunity to safely harvest shellfish because of the health risks associated with the urban land uses.

Land Cover Type	Percent Change in Land Cover 1991 - 1999	Change in Square Miles
High level of development 75% or more area covered with parking lots, streets, roof tops	6.3 % increase	10 miles^2
Low-to-medium development Between 15 and 75% covered with hard surfaces	7.9 % increase	63 miles^2
Forest cover	8.5 % decrease	-241 miles^2

Federal agencies identified the loss of habitat from stormwater runoff as one of the primary obstacles to salmon recovery.

Aerial photograph shows growing urbanization in the Sound region. / 1000 Friends of Washington

The Partnership's Work to Manage Stormwater Runoff

The Action Team partnership strives to improve the management of stormwater runoff in the Puget Sound basin by:

- Providing education and technical assistance to local governments, citizens, and businesses to help them reduce the harmful effects of stormwater.
- Regulating stormwater management through the National Pollutant Discharge Elimination System (NPDES) Program.
- Encouraging techniques for low impact development to reduce stormwater runoff.

Stormwater Permits

Because of the destructive potential of stormwater runoff, the Clean Water Act directs federal, state, and local agencies to manage the discharge of stormwater to water bodies by means of the NPDES permit program. Ecology issues and oversees NPDES permits and provides assistance to permit holders. The program is split into two phases:

- Implemented in 1995, phase I covers the most populated areas of the region, state highways within those areas, many industries, and construction sites larger than five acres.

- Phase II expands permit coverage to include less densely populated cities and counties, smaller construction sites, and additional industries.

In July 2004, Ecology gave notice that it will issue the following permits in 2005:

- Renewal of phase I municipal permits for densely populated areas: Seattle, Tacoma, and unincorporated King, Pierce, and Snohomish counties.
- Renewal of the general industrial permit for approximately 1,200 businesses in Washington that discharge stormwater to lakes, streams, or marine waters.
- New phase II municipal permits for more than 75 smaller cities and counties in the Puget Sound basin.
- New general construction permit for sites greater than one acre.
- New statewide permit for Washington Department of Transportation's (WSDOT) activities to manage highway stormwater runoff in areas covered by phase I and phase II permits.

Technical Assistance for Local Government

Action Team staff, Ecology staff, and water quality field agents from the University of Washington and Washington State University provide extensive assistance to Puget Sound local governments.

Action Team staff located in field offices around the Sound develop and share technical and educational materials, offer presentations, convene workshops, and review draft local government regulations. Ecology staff provide technical expertise to use the *Stormwater Management Manual for Western Washington*, help local governments meet requirements of their stormwater permits, and offer technical workshops.

Water quality field agents offer regular classes and workshops and collaborate with state agencies on technical documents, such as the *Low Impact Development Technical Guidance Manual for Puget Sound.* Together, these offices help local governments develop effective local programs to manage stormwater.

In 2005, an additional 75 cities and counties will improve their management of stormwater in conjunction with Ecology.

Low Impact Development

The Action Team staff works with local jurisdictions to encourage low impact development (LID) practices. The goal of LID is to prevent harm to aquatic resources from land development by preserving native vegetation, minimizing impervious surfaces, and managing stormwater close to its source. Some LID methods include:

- Installing rain gardens, green roofs, and permeable pavement.
- Retaining native plants and soils.
- Amending soil with compost and restoring vegetation.
- Harvesting rainwater for use.

Thirty-three percent of the cities and counties that responded to a 2004 stormwater survey have adopted or revised ordinances to allow for low impact development. A number of other local governments who were not surveyed have also added LID to regulations and drainage manuals.

Action Team staff, Washington State University Extension, Pierce County, and Ecology developed the region's first technical guidance manual for low impact development. The purpose of the manual is to provide site designers, stormwater engineers, developers, and other professionals with a common understanding of individual LID practices. The manual includes new credits for the use of LID practices that allow stormwater engineers to reduce the size of conventional stormwater control facilities when they use LID methods.

Seattle Public Utilities has retrofitted several blocks of city streets with LID features. Stormwater runoff is directed from narrow, curbless streets to planted bioretention swales for treatment and infiltration. Seattle found that the new design costs less than conventional construction that provides comparable water quality treatment. / Seattle Public Utilities

Stormwater Success Stories

Seattle Pilots Low Impact Development with SEA Streets

Seattle Public Utilities has led the way in applying LID techniques in Puget Sound with its SEA Streets (Street Edge Alternatives) project and received national attention for its performance and beauty. Seattle Public Utilities redesigned a city street to reduce stormwater runoff by reducing pavement by 11 percent compared to a typical street, directing runoff to vegetated ditches, and adding more than 100 evergreen and 1,100 shrubs to capture stormwater while beautifying the street. Monitoring results from the University of Washington show the project reduced stormwater runoff by 97 percent over several wet and dry seasons. The success of SEA Streets convinced the city to retrofit streets in a 15-block area with LID features.

Bellingham Installs Rain Gardens
The City of Bellingham, interested in providing better protection for Lake Whatcom and Whatcom Creek, installed two rain gardens to capture stormwater runoff from two city-owned parking lots. The rain gardens saved the city 75 to 80 percent in construction costs compared to conventional stormwater systems.

Controlling Highway Runoff
WSDOT completed a major revision and update of its Highway Runoff Manual in March 2004 to be consistent with Ecology's updated stormwater manual. The manual provides guidance for new, cost-effective, best management practices that improve treatment of highway runoff. WSDOT intends to use the manual statewide, even in areas not covered by NPDES permits. Ecology granted conditional approval of the manual in 2004.

In March 2004, WSDOT retrofitted an Interstate-5 stormwater outfall near Fort Lewis. It constructed an oil/water separator and a large detention pond to treat highway runoff, and to keep it from entering Murray Creek, a small salmon stream.

Continuing Challenges with Stormwater

Effectively managing stormwater and preventing environmental harm is an uphill battle. As more of Puget Sound becomes urbanized, stormwater becomes more of a problem. Local governments are struggling to manage stormwater runoff, protect aquatic resources, and meet state and federal stormwater mandates in an efficient and cost-effective manner.

- Conventional stormwater infrastructure such as catch basins, pipes, and retention and detention ponds can be expensive and difficult to construct and maintain. Many governments cannot afford to hire enough staff to cover routine maintenance of already-built storm water systems. For example, the city of Tacoma has more than 17,000 catch basins and more than 700 miles of stormwater pipe to maintain. Many systems around Puget Sound go without proper maintenance and may actually contribute pollutants rather than remove them.

- Even when properly designed and installed, conventional pipe and pond systems do little to remove certain pollutants, such as pathogens, and do not protect stream flows, fish and wildlife habitat, and drinking water aquifers as a watershed is developed.

- Projects in the region, across the U.S, and in Europe demonstrate that LID techniques can provide viable, cost-effective alternatives to conventional stormwater management systems. This information warrants the use of LID techniques in residential, commercial, and industrial settings. However, questions remain and research is needed regarding the long-term performance, maintenance requirements, and relative cost of LID techniques.

- Given the region's unique soils, meteorological conditions, and sensitive aquatic resources, additional LID pilot projects and research are needed so that professionals in the region can learn more about them and become more proficient in using them.

When pavement, roofs, and other hard surfaces replace forests, meadows, and other natural areas, they generate stormwater runoff.

Sprawl takes hold in Dupont. / © Aerolistphoto.com.

III. State of the Sound's HABITAT

Poorly planned development can disrupt nearshore processes that support living organisms on healthy, undisturbed shorelines. / Brian Walsh (photo, left)

Puget Sound is bestowed with diversity of habitats. The salt marshes, mudflats, sandy beaches, eelgrass, kelp beds, and rocky-reef habitats each support distinct communities of plants and animals. Habitat is more than the place where organisms live; it is also the collection of dynamic processes that deliver clean water, sunlight, shelter, nutrients, sediment, and other essentials that living organisms depend upon for their survival.

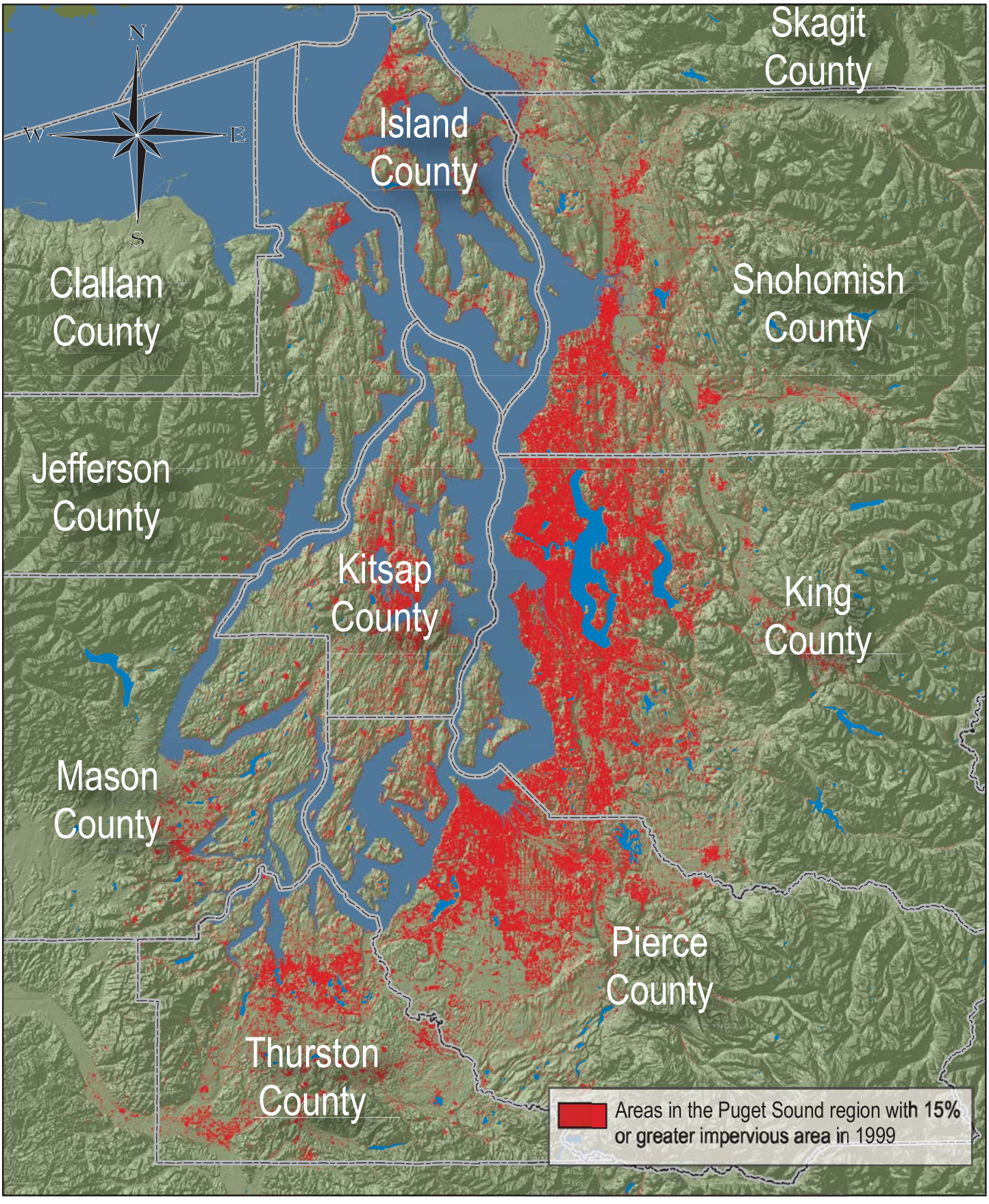
Puget Sound's habitat has suffered losses. One third or about 800 miles of Puget Sound's shorelines have been altered by development.[6] Shorelines have been armored with bulkheads, dredged, or filled in for human uses. Puget Sound has lost 73 percent of its salt marsh habitat since the 1800s with losses approaching 100 percent in urban bays.[7] Many species that rely on nearshore and marine habitats, such as forage fish, marine birds, salmon, and orcas have declined in population.

Urbanization is shattering Puget Sound habitat into fragments. As the pieces become progressively smaller and more isolated, they are less able to sustain the ecological processes necessary to support life. Eventually, if they are not reconnected and restored, the pieces lose much of their original value. As a result, the species that depended on these habitats decline in diversity and abundance.

A fractured landscape is also more susceptible to the invasion of foreign species. When species are in their native environment, their populations are usually kept in balance by predators or competitors for food supply. When exotic species land in new regions, they can spread unchecked, crowd out native plants and animals, reduce diversity, and alter the basic nature of the ecosystem.

Nearshore habitat extends from the upper part of the bank, down across the tidelands and into the water to depths where enough light penetrates to support the growth of algae and submerged plants. There, kelp and eelgrass are the underwater forests and meadows that give food, shelter, and migratory corridors to hundreds of species.

Impervious Surface in the Puget Sound Region in 1999



Source: University of Washington Urban Ecology Research Laboratory

INDICATOR: Lowland Habitat Loss

The quantity, quality, and interconnectedness of terrestrial and aquatic habitats in the Puget Sound region are all threatened by development. A University of Washington land study evaluated the lowlands (elevation below 500 meters) of the southern eight counties of the Puget Sound basin from 1991 and 1999. This study characterized developed lands based on how much impervious surface (e.g., pavement, roofs) was apparent from satellite imagery. Areas with 15 to 75 percent impervious surface are characterized as moderately developed. Areas with greater than 75 percent impervious surface are considered urban or highly developed.

Status

The predominant landscape types in the study area are forest (41 percent), grass and shrub (21 percent), and moderately to highly developed (16 percent). This mix reflects conversion of areas that were once forest and prairie, which provide the native habitat for numerous Puget Sound species, as well as agriculture, industrial, commercial, and residential uses. (The pattern of development in the lowlands of Puget Sound is indicated on a map on page 30.)

Trend

From 1991 to 1999, about 73 square miles, or just over 1 percent of the total area of land in the southern half of the Puget Sound basin was converted from forest, grass, or cropland to moderate or high degrees of development. During this period, this area of the basin lost 240 square miles of forest, or more than 8 percent of the region's forest cover, to development and logging.

From 1991 to 1999, the central Puget Sound basin lost 240 square miles of forest, or more than 8 percent of the region's forest cover, to development and logging.

INDICATOR: Eelgrass

Because eelgrass supports so many other plants and animals and plays a critical role in the ecosystem, eelgrass beds are considered a prime habitat. Eelgrass beds grow along the tidelands and shallow water of Puget Sound and are home to a variety of plants, fish, marine birds, invertebrates, and microbes. Eelgrass beds act as corridors for migrating salmon and nursery habitat for species with significant ecological, commercial, and recreational value, such as juvenile salmon and rockfish, herring, and crab.

In the winter, when eelgrass leaves die, the decaying litter provides food for bottom-dwelling animals. Eelgrass roots stabilize sand and mud, and anchor and buffer the beds from storms. Eelgrass is a valuable indicator of estuarine health, because it is sensitive to environmental change. Excess nutrients, sewage, and algae blooms can reduce the clarity of the water and limit the light available to eelgrass. Storms, runoff, and dredging can stir up sediment and also prevent light from penetrating into deeper water. Boat wakes, propellers, and docks can disturb eelgrass beds. Bulkheads and other structures can increase wave energy and alter the sediments where eelgrass grows.

Eelgrass beds act as corridors for migrating salmon and nursery habitat for species with significant ecological, commercial, and recreational value, such as juvenile salmon and rockfish, herring, and crab.

Status

Since 2000, DNR has monitored eelgrass in Puget Sound at 76 randomly selected sites. DNR tracks the total abundance and depth of eelgrass beds. DNR estimates that approximately 50,000 acres of eelgrass beds are in Puget Sound. The depth of eelgrass beds varies throughout the Sound, depending on environmental characteristics, including light availability in the water column.

Trend

During the first three years of monitoring, the amount of eelgrass in Puget Sound remained relatively stable. However, between 2002 and 2003, DNR detected a 4 percent Soundwide decline, mainly in north Puget Sound and Hood Canal. At the site level, the majority of eelgrass beds were stable with most sites showing less than 10 percent fluctuation between years. The Action Team partnership is concerned that entire eelgrass beds can be lost very quickly. For example, Westcott Bay on San Juan Island had 35 acres of eelgrass in 2001, but most of the eelgrass was gone by 2003.

Understanding and Responding to Eelgrass Losses

DNR is working with other groups to find the cause of the decline of eelgrass beds in Wescott Bay, and has sampled additional sites in the San Juan Islands to determine if the decline is part of a larger pattern. The agency has proposed more intensive monitoring to better understand stresses to eelgrass beds. It has also proposed developing a seagrass management plan.

INDICATOR: Spartina Infestation

Spartina is a type of salt marsh grass that is native to the Atlantic coasts of Europe and North America. People introduced spartina to the region as packing material for imported oysters, feed for cattle, and to stabilize shorelines. Spartina forms dense colonies that severely limit habitat diversity. When it invades mudflats, it traps sediments and raises the elevation until the habitat is no longer suitable for mudflat species. It can raise a mudflat to heights that cut off shellfish production.

In salt marshes, spartina crowds out other plants and results in less diverse animal populations. Spartina can quickly form extensive meadows that rob migratory shorebirds and waterfowl along the Pacific flyway of habitat for forage and refuge.

Status

In Puget Sound, spartina spread from less than 15 acres in 1979 to 1,000 acres by 1997. By 2004, 680 acres infested the Sound.

Trend

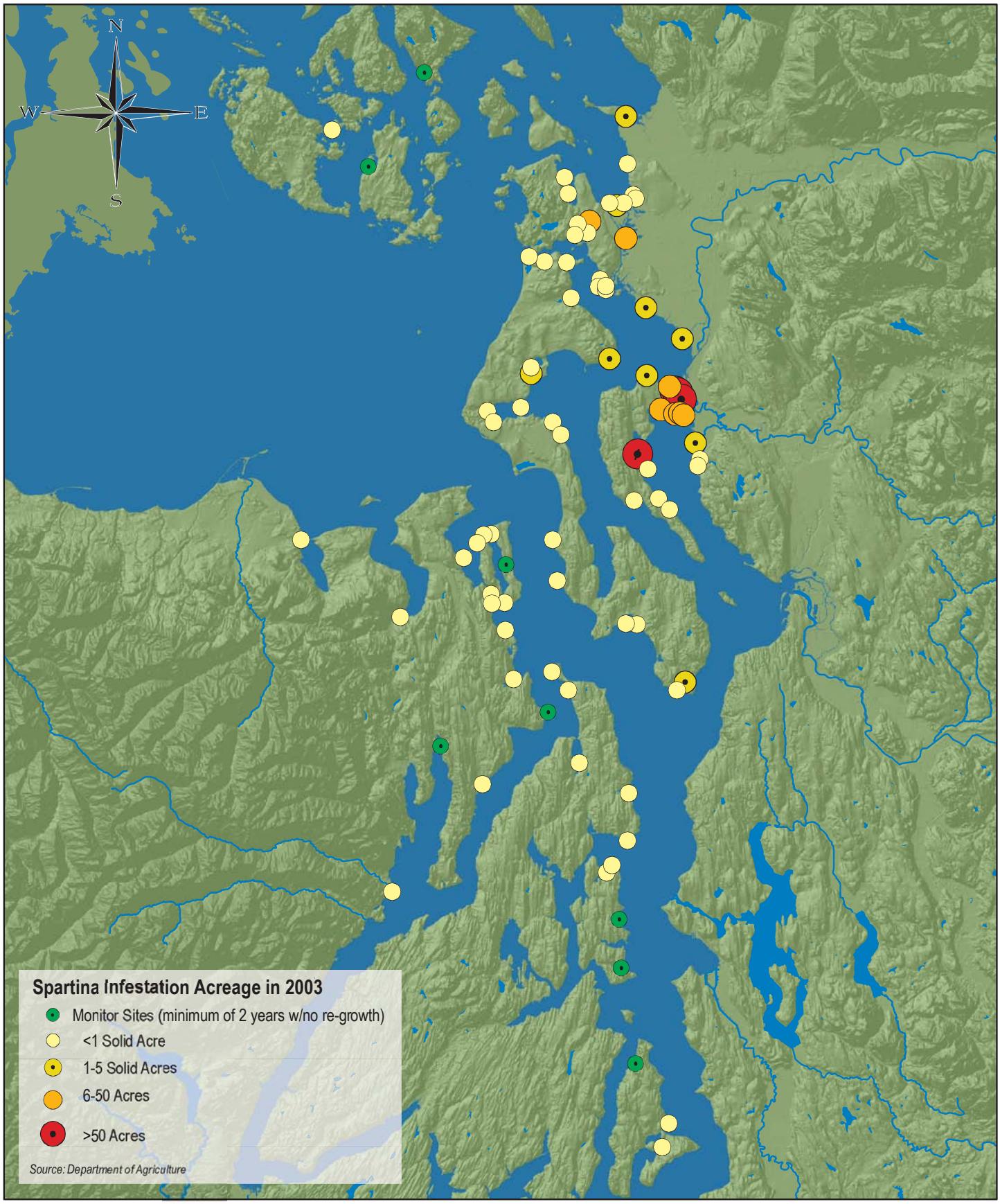
Agriculture estimates that there were 760 acres of spartina in the Sound at the beginning of the 2003 treatment season. By 2004, the agency and its partners reduced the infestation to 680 acres. From 1997 to the beginning of the 2004 treatment season, Agriculture reduced the total area of spartina in the Sound by 33 percent. Agriculture considers plants to be eradicated after two years without re-growth.

Whatcom County Noxious Weed Control Board, the Vancouver BC Aquarium, and Action Team staff worked together to remove spartina in Boundary Bay.

Alien Sea Squirt Invades Puget Sound

A tunicate, or sea squirt, colony native to Europe has invaded Puget Sound. When a NOAA diver first noticed it in April 2004, the colony covered about two square feet on the wreckage of an old wooden boat sunk in the undersea park at Edmonds. The colony had grown to about six square feet by fall of 2004. The sea squirt's rapid reproduction can crowd out organisms, such as native sponges, anemones, mussels, and oysters. It has no known predators. In October 2004, volunteer divers tarped off the area and applied chlorine tablets to kill the animals.

Puget Sound Spartina Infestations



The Partnership's Work to Protect Habitat

The Action Team partnership and the communities of Puget Sound are working to prevent further losses and achieve a net gain in freshwater and marine habitat by:

- Issuing permits, regulating resource use, and enforcing environmental laws and safeguards.
- Acquiring valuable habitat and restoring damaged habitat.
- Educating and encouraging people to protect habitat.
- Controlling invasive species.

Regulation

Regulations are necessary to ensure land is developed in a way that protects valuable habitat and other public values and interests in Puget Sound. The Washington State Legislature has passed two critical pieces of legislation to manage growth. The Growth Management Act (GMA), adopted in 1990, requires cities and counties to create growth management plans and to adopt ordinances to protect critical areas. In 1971, the legislature passed the Shoreline Management Act (SMA) into law. It regulates all uses of the state's shoreline. Local governments carry out these regulatory programs.

Haphazard shoreline development can harm nearshore habitat, reduce property values, and expose people to danger. / Jim Johannesson

In the 2003-05 state budget, the Legislature allocated $2 million to help local governments update their Shoreline Master Programs (SMP), with more funding expected throughout the next decade. State law requires that Puget Sound cities and counties update their SMPs between 2005 and 2012.

Ecology provides guidelines that direct how local governments prepare SMPs. In December 2003, Ecology adopted the first changes to SMP guidelines in 30 years. The revised guidelines mark a new era in shoreline protection, using science and policy that have improved substantially since the 1970s. The guidelines set a high standard of no net loss of ecological functions on the shoreline.

Cities and counties are also updating their growth management plans and ordinances to bring them into compliance by the end of either 2004 or 2005, depending on the jurisdiction. This includes updates of Critical Areas Ordinances (CAOs), which can be important tools for the protection of Puget Sound. CTED establishes guidelines and provides funding and technical assistance to local governments as they update. CAO regulations protect:

- Aquifer recharge areas.
- Frequently flooded areas.
- Wetlands.
- Geologic hazard areas.
- Fish and wildlife habitat.

Using Science to Protect Puget Sound

State law requires local governments to include the best available science to protect eelgrass, kelp beds, forage fish spawning beaches, salmon habitat, and shellfish growing areas when developing their CAOs. If a lack of scientific information exists, the state encourages local governments to take a precautionary approach to protect resources from the impacts of development until the uncertainty is resolved. The science on how to best protect Puget Sound habitat is evolving rapidly, but gaps remain. To help fill the gaps:

- CTED published the *Critical Areas Assistance Handbook* in November 2003. The book provides the best available science recommended to help local governments with their critical areas updates.
- Ecology produced the *Best Available Science Guidance for Freshwater Wetlands*.
- As part of the salmon recovery plan for Puget Sound, Action Team staff are helping local governments and watershed groups identify and protect nearshore habitat critical to salmon recovery. The plan will be completed in 2005.
- WDFW, with assistance from other Action Team partners, is developing recommendations on best practices for marine nearshore protection, including the use of local ordinances and voluntary landowner stewardship programs.
- Inventories of nearshore resources, critical to knowing where important natural resources are and how much of them there are, have significantly improved in recent years, due to mapping efforts by WDFW, DNR, marine resource committees, local governments, and others.

Types of Habitat Acquired or Restored

Type of Habitat Acquired	2003	2004
Beaches and dunes	0	25
Estuarine	2,494	1,094
Riparian	761	533
Uplands	362	469
Wetlands	34	1,124
Total	**3,651**	**3,245**

Acquisition and Restoration

Since acquiring high quality terrestrial and aquatic habitat is one of the most effective ways to protect them, the Action Team partnership supports efforts to acquire and conserve public and private lands. Strategic acquisition can reconnect habitats into a network better able to protect native plants and animals. Habitat safeguarded through acquisition protects Puget Sound's health, adds to outdoor recreation opportunities, and creates a legacy for future generations.

Grant funds for acquisition and restoration come from WDFW, U.S. Fish & Wildlife Service, the Interagency Committee for Outdoor Recreation (IAC), and NOAA. The grant funds leverage additional resources from local and tribal governments, and environmental and conservation organizations to achieve the restoration of habitat processes. About three-quarters of the acreage in the table above were acquisition projects.

While acquisition is critical to the long-term health of Puget Sound, if the Sound is to regain its historic abundance and diversity, restoration of damaged areas is also necessary. During the last two years, a host of entities have worked diligently on a vision of large-scale ecosystem restoration in Puget Sound's nearshore environment. The Puget Sound Nearshore Ecosystem Restoration Program has taken the lead role to restore natural processes in Puget Sound. The group is conducting a strategic assessment of restoration needs for Puget Sound's nearshore habitat. It is creating a plan that will build upon the array of existing restoration efforts. The plan will demonstrate the benefits of coordinating restoration in the region andadditional involvement by the U.S. Army Corps of Engineers in landscape-scale restoration projects.

Protecting Public Aquatic Lands

DNR's Aquatic Reserve Program has the potential to protect aquatic habitat on public lands. DNR accepts nominations for three types of reserves—environmental, scientific, and educational. DNR works with communities to develop a management plan for each reserve, which outlines strategies to preserve, enhance, restore, and create high quality aquatic habitat. DNR recommended six sites in Puget Sound for the Aquatic Reserve Program in 2003. In 2004 and 2005, DNR will develop management plans for sites on Maury Island in South Sound, Cherry Point near Bellingham, Cypress Island in the San Juans, and Fidalgo Bay near Anacortes. In addition to the four sites under review, DNR withdrew 22 acres in two sites in Commencement Bay from leasing in 2004, but they were not recommended for Aquatic Reserve status.

DNR has partnered with The Nature Conservancy in a new program to create leases for habitat protection and restoration on aquatic lands.

WDFW uses volunteers to monitor the presence of green crab at 100 sites in Puget Sound. / Brent Dumbauld

Since 1997, the Department of Agriculture and its partners reduced infestations of spartina in the Sound by 33 percent.

DNR is also assessing how its management of publicly owned aquatic lands, such as leasing, over-water structures, outfalls, and mooring facilities affect species that are protected by the federal Endangered Species Act. The assessment will lead to development of a Habitat Conservation Plan for state-owned aquatic lands.

Public Involvement, Education, and Stewardship

Sea Grant, WSU Extension, and Action Team staff have partnered with local governments and other groups to educate shoreline property owners about how to live in better harmony with the nearshore environment. Trainings held in Hood Canal, Bainbridge Island, Kitsap, Island, Pierce, and Whatcom counties in 2003 and 2004 educated shoreline residents about using alternatives to bulkheads to control erosion; landscaping and building techniques that reduce stormwater runoff; and maintaining septic systems to prevent pollution.

Control of Invasive Species

Action Team agencies in partnership with local governments have adopted safeguards to control the introduction and spread of invasive species:

- As a result of legislation passed in 2000, ships must exchange ballast water taken up in other coastal areas for ballast water from the open ocean, before being allowed to release ballast water into Puget Sound. By 2007, if a vessel has not been able to do such an exchange, they must instead treat the water prior to release to kill any non-native species.
- Since legislation passed in 2002, it is illegal to have any aquatic plants on a boat, motor, or trailer. As a result, WDFW and the Washington State Patrol now conduct inspections of tailored boats.
- Agriculture and WDFW work with local noxious weed boards, tribal governments, universities, environmental groups, and citizens to control spartina. The agency has made significant progress, reducing infested areas from 1,000 acres in 1997 to 680 acres in 2004.

Habitat Success Stories

Critical Areas Ordinance Slows Shoreline Armoring
Thurston County regulates shoreline armoring through standards in its CAO. People who want to build a bulkhead must first submit geotechnical reports and then retain vegetation on slopes and tops of bluffs. Before the CAO was adopted, Thurston County permitted the construction of new bulkheads at the rate of nearly 2,600 feet per year, resulting in nearly 4.5 miles of shorelines armored between 1985 and 1995. After the county adopted the standards, the rate of bulkhead construction slowed to 300 feet per year—less than one-third mile of shoreline was armored from 1995 to 1999. The CAO was the tool that made the difference for reducing shoreline armoring in Thurston County.

First-of-a-kind Restoration
The Nisqually River has the largest and least disturbed delta in Puget Sound. Much of it is in good condition, but for 100 years, dikes have blocked the delta's connection to Puget Sound. In 2002, the Nisqually Tribe removed a dike to restore 110 acres of salt marsh in the delta. This is the first project of its kind in Puget Sound.

Largest Acquisition Since the Nisqually Refuge
A large partnership of three federal agencies, two state agencies, a county, a land trust, two conservation organizations, and a private contributor purchased 1,589 acres of tidal wetlands in the Snohomish delta for preservation and eventual restoration. This is the largest single acquisition of estuarine wetlands in Puget Sound for preservation since the purchase of the Nisqually National Wildlife Refuge in 1974.

Multiple Bang for the Restoration Buck
While not a huge acquisition, the purchase of 107 acres of riparian floodplain at the confluence of the Salmon and Snow creeks in Jefferson County is important because it is strategically located to protect water quality, salmon migration and rearing, and estuarine processes in Discovery Bay. Identifying habitat that provides multiple "bangs" for the restoration buck will be a key strategy for future acquisition and restoration planning.

Early Planning Saved Eelgrass at Clinton Ferry Dock
When WSDOT expanded the ferry dock at Clinton, it protected eelgrass by installing glass blocks to let light through a walkway, painted the underside of the dock for light reflection, and built structures further offshore, outside the range of the beds. They stockpiled and cultivated eelgrass shoots in tanks and used them to replant 14,230 feet of eelgrass on the site. WSDOTs early planning made all the difference between saving a resource and destroying it.

Continuing Challenges to Protect Habitat

As people expand their activities in the Puget Sound region, habitats for plants and animals shrink. Given the sheer numbers of people and the breadth of human activities, these cumulative impacts place a great deal of pressure on Puget Sound's habitat. This creates a number of challenges to achieve permanent protection of habitat in Puget Sound.

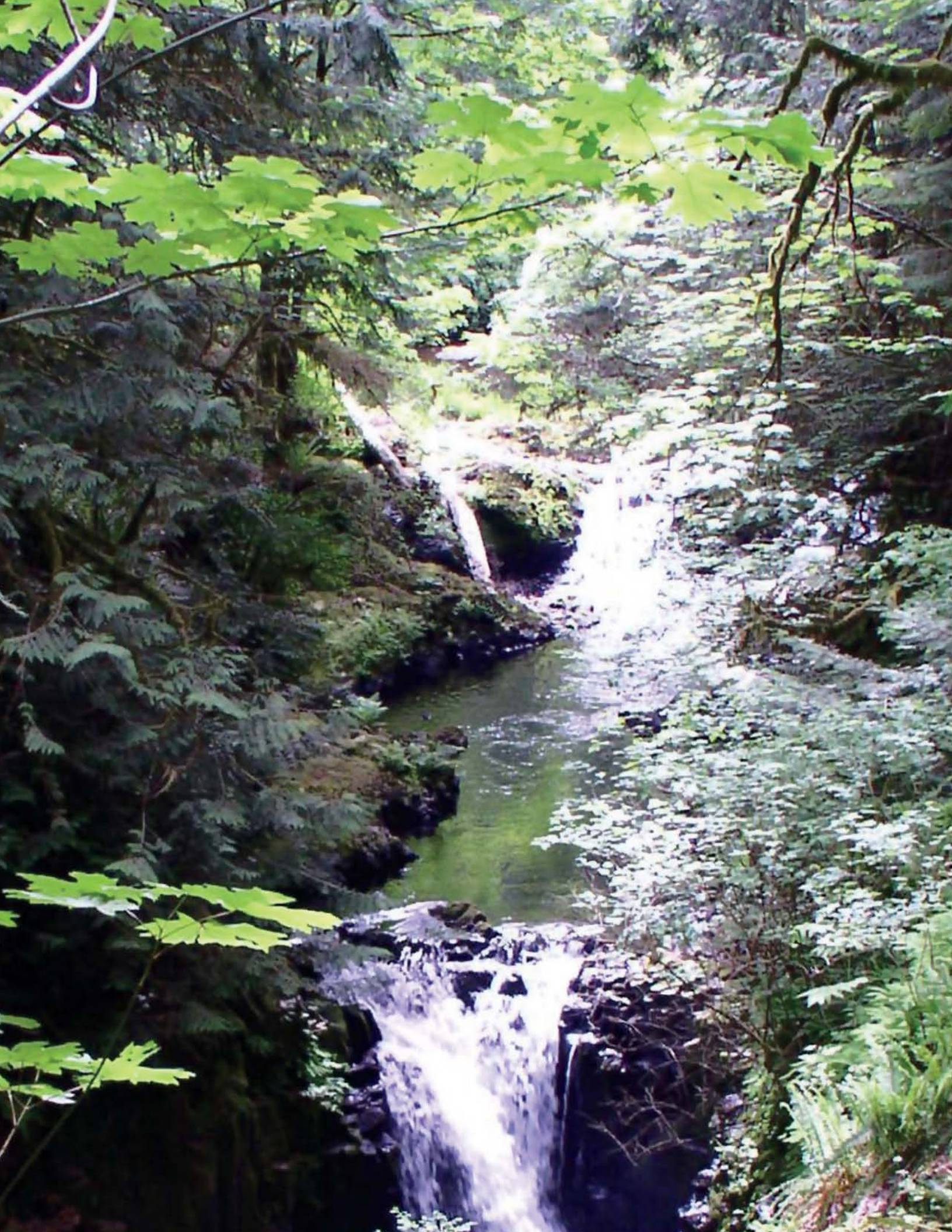
- The most valuable land for protection is very often the most valuable real estate. Resolving this direct tension between competing uses and interests on high value lands may be the defining challenge to protect Puget Sound's habitat.

- Almost all actions taken in the nearshore and shoreline environment matter to habitat, no matter how small, as the cumulative impacts of many small, individual actions can be very severe. Managing individual actions with an understanding and appreciation of cumulative impacts is necessary.

- A great deal of energy and money is spent in the region on acquisition and restoration. The challenge is to assure that this investment is delivering the highest environmental returns. Coordinated and more strategic management of habitat acquisition and restoration activities in Puget Sound is needed, including better coordination of grant funding. Present practices sometimes lead to limited financial and staff resources being spread across too many projects, and result in ineffective and piecemeal fixes.

- The kinds of restoration projects that will most make a difference in Puget Sound are those that restore ecological processes on a landscape scale. Large-scale projects are extremely challenging, requiring a high level of cooperation and collaboration across multiple jurisdictions.

As people expand their activities in the Puget Sound region, habitat for plants and animals shrinks.



IV. State of the Sound's SPECIES

The living resources of Puget Sound are the ultimate indicators of its health, and the picture they paint is very troubling. The Sound's diverse web of life is at risk. The building blocks of a healthy environment—clean water, abundant habitat, and an intact food web—are eroding. The effects of this erosion are being seen in declines in eelgrass, forage fish, salmon, rockfish, marine birds, and orcas. These losses may become self-reinforcing, as declines in eelgrass and forage fish can trigger a domino effect that results in the collapse of many other populations of species throughout the Sound.

INDICATOR: Species at Risk

U.S. Fish & Wildlife Service and NOAA Fisheries protect species through the federal Endangered Species Act (ESA). In Washington State, the Washington Fish and Wildlife Commission designates species for special attention under state authorities. Each agency then creates and carries out recovery plans for species they designate as threatened or endangered.

Status

As of June 2004, 40 animals in Puget Sound were on the federal and Washington state lists of threatened, endangered, or candidate species that need special protection.

- 31 of the 40 animal species are candidates for federal or state protection.
- Seven animal species are listed by the federal government as endangered or threatened.
- Six animal species are listed as endangered or threatened by the state of Washington.

Trend

Action Team staff have not developed trend information for this indicator because of the concern that the number of species on the various federal and state lists change as a result of administrative action as much as through changes in the condition of species. The other indicators in this chapter present trend information for specific animals.

The Sound's diverse web of life is at risk.

Wolf eel and sea anemones / *Jennifer Vanderhoof*

Right:
Species at Risk in Puget Sound
Listing Key:
E = Endangered
T = Threatened
C = Federal Species of Concern or Washington State Candidate

Federal Definitions of ESA Terms
Endangered: Any species in danger of extinction throughout all or a significant portion of its range.

Threatened: Any species likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Species of Concern or Candidate Species: Any species being considered for listing as threatened or endangered.

Animal Species at Risk in Puget Sound*

Group	Common Name	State Status	Federal Status
Marine Mammals	Northern Pacific Humpback Whale	E	E
	Steller Sea Lion	T	T
	Orcas[8]	E	C
	Pacific Harbor Porpoise	C	
	Northern Sea Otter	E	
Birds	Bald Eagle	T	T
	Canada Goose, Aleutian	C	
	Golden Eagle	C	
	Marbled Murrelet	T	T
	Tufted Puffin	C	
	Brandt's Cormorant	C	
	Cassin's Auklet	C	
	Common Murre	C	
	Western Grebe	C	
Marine and Anadromous Fishes[9]	Chinook Salmon (Puget Sound)	C	T
	Chum Salmon (Hood Canal/E. Strait of Juan de Fuca)	C	T
	Coho Salmon (Puget Sound/Strait of Georgia)		C
	Bull Trout	C	T
	Pacific Hake	C	C
	Pacific Cod	C	
	Walleye Pollock	C	
	Pacific Herring (Cherry Point/Discovery Bay)	C	C
	Brown Rockfish	C	
	Copper Rockfish	C	
	Greenstriped Rockfish	C	
	Widow Rockfish	C	
	Yellowtail Rockfish	C	
	Quillback Rockfish	C	
	Black Rockfish	C	
	China Rockfish	C	
	Tiger Rockfish	C	
	Bocaccio Rockfish	C	
	Canary Rockfish	C	
	Redstripe Rockfish	C	
	Yelloweye Rockfish	C	
	Eulachon	C	
	River Lamprey	C	
Invertebrates	Olympia Oyster	C	
	Newcomb's Littorine Snail	C	
	Pinto (Northern) Abalone	C	

** federal and state listing status as of June 2004*

INDICATOR: Salmon

Salmon have long sustained the Salish and maritime cultures that form the roots of the unique Northwest identity. For millennia, the rivers and sea teemed with fish each year—dependable, superabundant, and seemingly unlimited. The loss of this once-abundant natural bounty is a potent sign that the Sound's ecosystem is in jeopardy.

Salmon are born in freshwater and migrate to saltwater. Many enter the ocean for some part of their lives and must return to freshwater to spawn. Salmon rely on Puget Sound's nearshore and marine environments for food, refuge, and migratory corridors on their journey to and from the ocean. The range of salinities in the Sound helps them undergo the vulnerable transition from fresh to saltwater.

Coho salmon / Jamie Glasgow, Washington Trout

Status

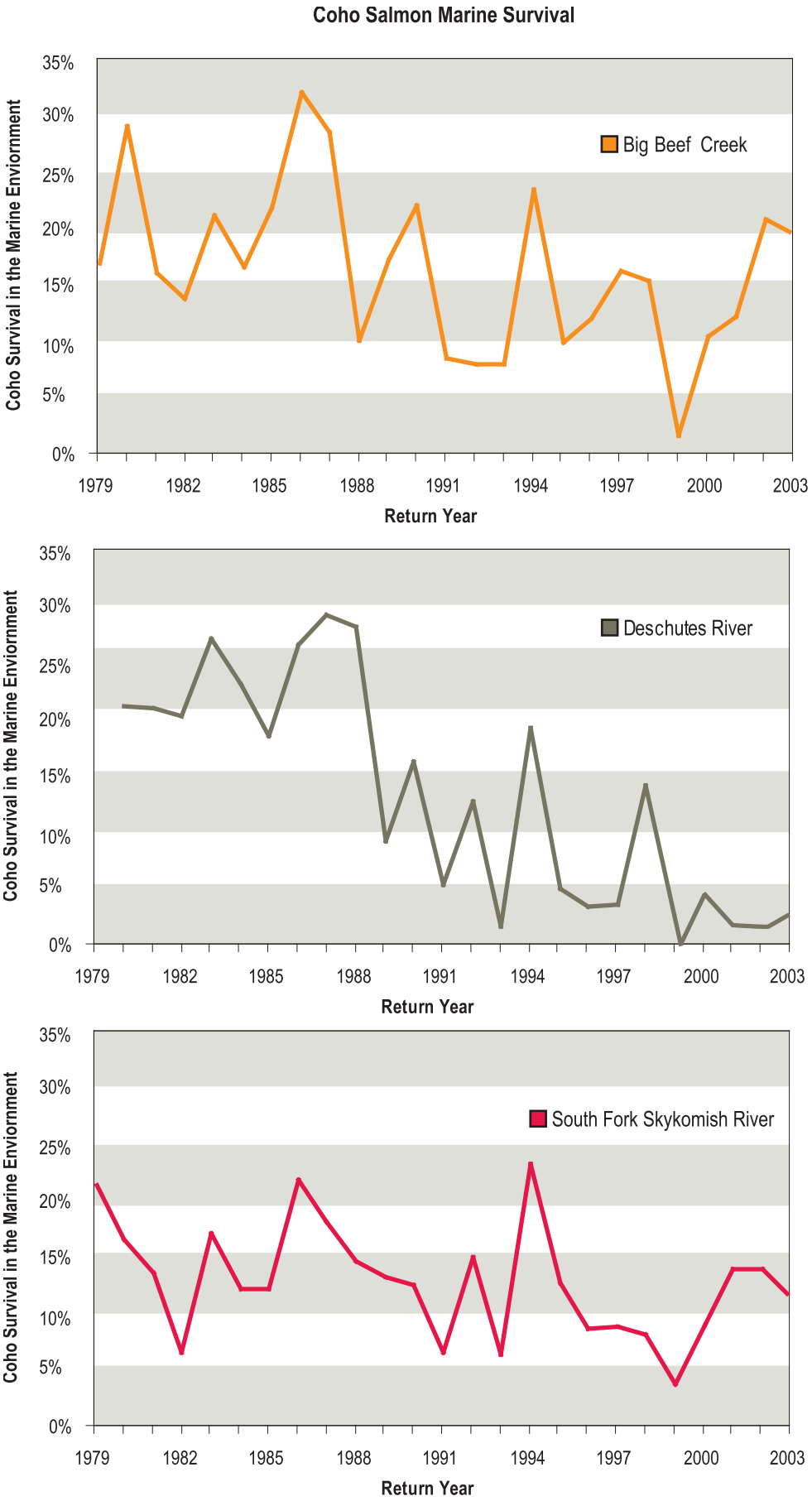
As shown in the table on page 42, populations of chinook salmon, Hood Canal summer chum, and bull trout are listed as threatened under the ESA. Coho salmon in this region are federally designated as a species of concern.

Salmon harvest in recent years is far below historic levels. In 1908, fishing crews landed a record catch of 690,000 chinook from Puget Sound.[10] In recent years, chinook harvest has averaged 64,000 fish in Puget Sound commercial net and troll fisheries and fewer than 50,000 fish in recreational fisheries.[11]

Trend

The only trend data available is for marine survival of coho, which has been studied in three Puget Sound streams for two decades. This information is not available for coho from other streams or for other species of salmon in Puget Sound.

Survival of coho through the marine portion of their life cycle declined from around 20 percent in the late 1980s to less than 5 percent in 1999. Since that low point, marine survival rates have rebounded for coho returning to two of the three Puget Sound streams that have been monitored. The rate of marine survival for coho returning to the Deschutes River, however, remains at very low levels. The cause of the continued poor survival in coho returning to extreme southern Puget Sound is unknown.



Survival of coho depends on a number of factors in both freshwater and marine environments. Three of 24 coho stocks in Puget Sound have been studied for two decades to determine their marine survival rates.
Source: WDFW

INDICATOR: Rockfish

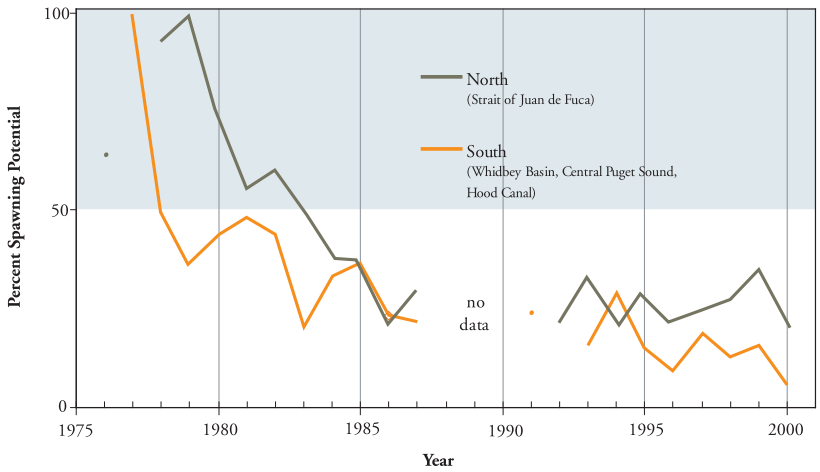
Rockfish include many species of long-lived, slow-growing marine fish that tend not to stray from their homes in the rocky reefs of Puget Sound. Some species live for 100 years. Many do not reach sexual maturity until they are five to seven years old or older.

The condition of a rockfish stock is measured by its potential to produce offspring, or its spawning potential. Spawning potential declines when there are fewer fish of spawning age or when individual fish produce fewer eggs. Older rockfish have much higher spawning potential because they produce many more offspring than younger fish and their offspring are more likely to survive.

Depleted stocks take a long time to recover because of late sexual maturity and relatively low birth rates of younger and smaller fish. Long-lived species with low birth rates tend to be more vulnerable to loss and for that reason are sensitive indicators of human caused damage.

Copper rockfish / Jennifer Vanderhoof

Decline in Spawning Potential of Copper Rockfish



Status

Spawning potential of some rockfish populations in Puget Sound have fallen to 10 percent or less of their historical levels. Thirteen species of rockfish are candidates for listing under the state's endangered species act.

Trend

Rockfish stocks throughout Puget Sound have shown drastic declines in the past 25 years either because of fewer fish or smaller size of individual fish. In 2000, spawning potential of copper rockfish in northern Puget Sound was 12 percent of the level recorded in 1978 (an 88 percent decline) and the level in southern Puget Sound was only 7 percent of the 1978 level (a 93 percent decline). No new data are available since 2000 to provide information about the recent directions in these trends.

Rockfish Spawning Potential
The condition of a rockfish stock is measured by its potential to produce offspring, or its spawning potential. Spawning potential declines when there are fewer fish of spawning age or when individual fish produce fewer eggs. The spawning potential of copper rockfish has declined dramatically since 1975.
Source: WDFW

INDICATOR: Herring

Pacific herring, sand lance, and surf smelt are the most important forage fish in Puget Sound. Forage fish school in such large numbers that they are often measured in biomass or weight rather than numbers of fish. Forage fish form a huge link in the Puget Sound food web. They feast on the billions of zooplankton in Puget Sound and transfer this enormous energy up the food chain to larger animals. Forage fish are valuable indicators of Puget Sound's productivity because they are food for marine birds and predatory fish, such as salmon. Indirectly, they provide food for orcas and other animals that rely on salmon.

Forage fish are valuable indicators of Puget Sound's productivity because they are food for marine birds and predatory fish, such as salmon. Indirectly, they provide food for orcas and other animals that rely on salmon.

Status

Herring have been monitored in Puget Sound for several years. The 19 herring stocks in Puget Sound are identified by where they spawn. As shown in the table below, WDFW classifies most Puget Sound herring stocks as healthy or moderately healthy. Three stocks are classified in relatively poor condition: one is classified as depressed and two as critical. The status of one stock is unknown.

Herring Stocks

Herring Stocks	2000	2002*
Healthy	10 stocks	8 stocks
Moderately Healthy	2 stocks	7 stocks
Depressed	3 stocks	1 stocks
Critical	2 stocks	2 stocks
Unknown	1 stock	1 stock

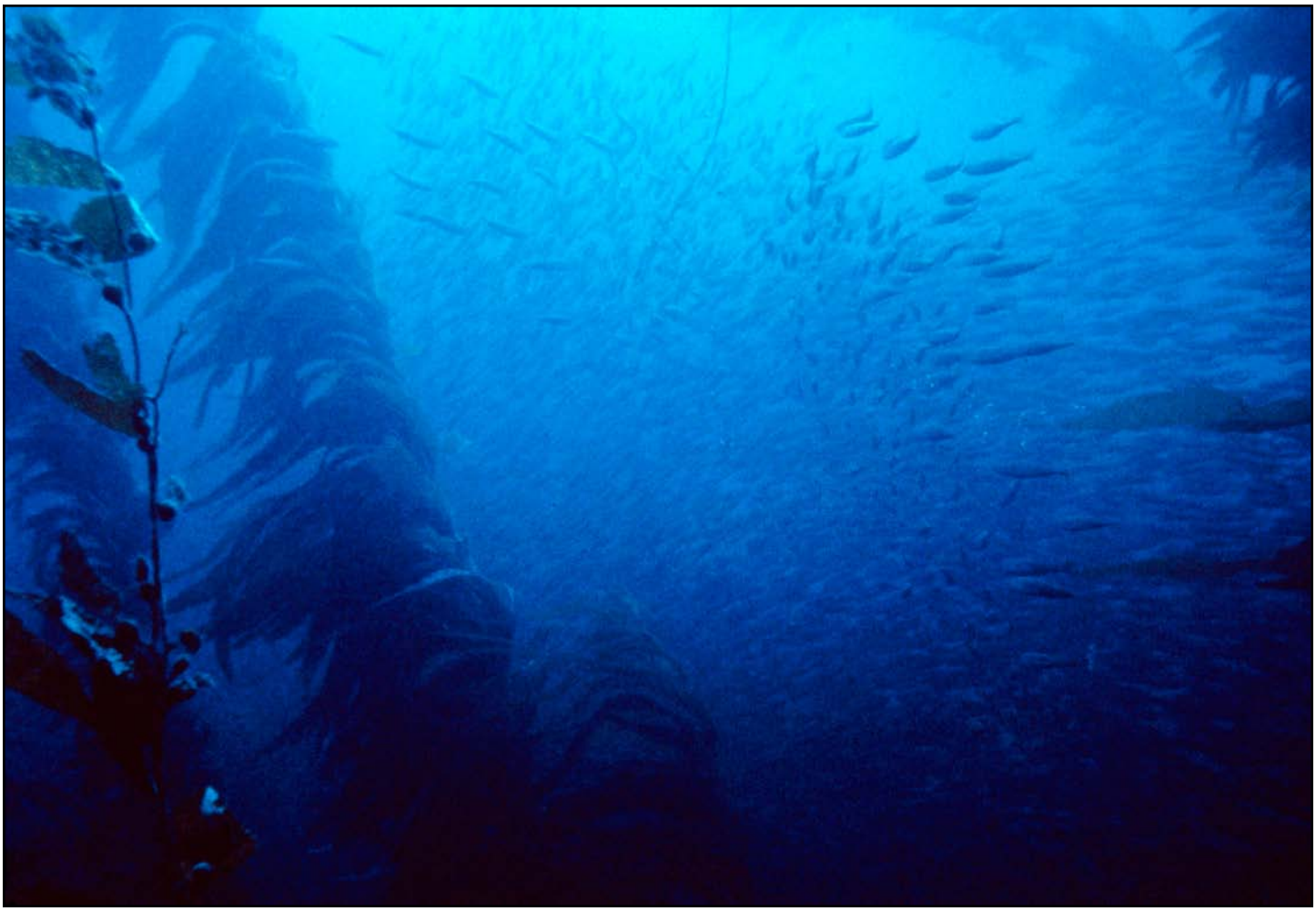
**WDFW surveyed 19 spawning grounds in 2002 compared to 18 in 2000. The spawning ground at Wollochet Bay was not surveyed prior to 2002. Source WDFW*

Trend

WDFW estimates that Puget Sound produced between 15,000 and 18,000 tons of herring in 2002 and 2003–an overall increase from lows of 10,000 to 11,000 tons in 1997 and 1998. The growth can be attributed to increases in stocks spawning in areas south and east of Admiralty Inlet.

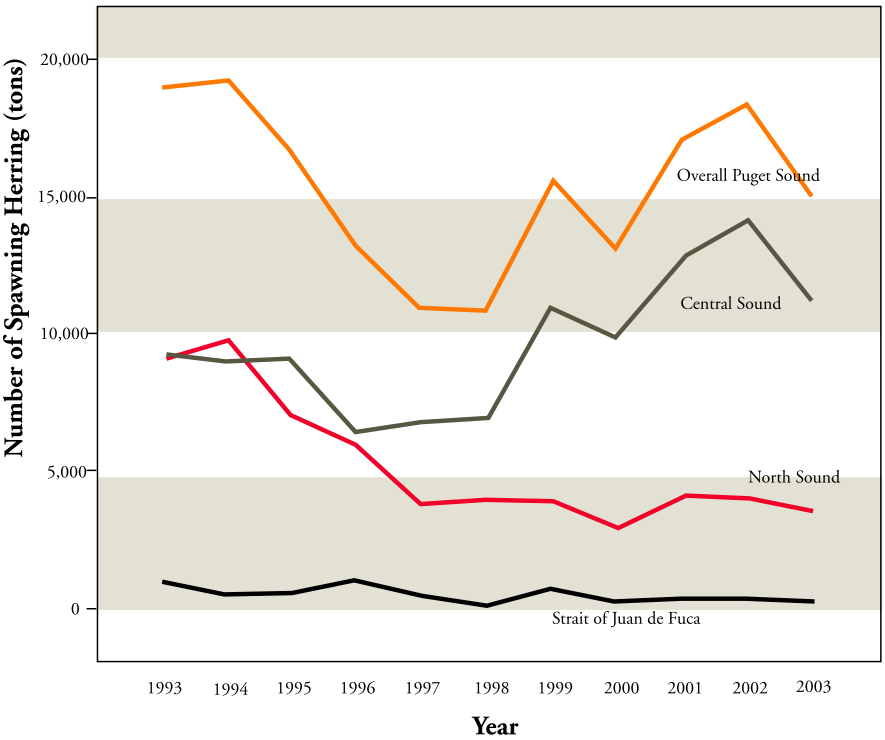
Herring populations have declined in some spawning areas. Herring in the Strait of Juan de Fuca have shown a steady decline since the mid 1980s. Cherry Point herring, once the largest stock in Washington State, have shown steep declines during the past few decades. The stock dropped from 10,000 tons in 1994 to a low of 808 tons in 2000, a decline of 92 percent. The Cherry Point population has increased slightly in recent years to 1,611 tons observed in 2003. This is an improvement, but much lower than the minimum spawning goal of 3,200 tons that WDFW sets for this stock.

Changes in stock status shown in the Herring Stock table indicate trends for five stocks. Two stocks from Quartermaster Harbor and Port Gamble declined from healthy to moderately healthy. Three stocks from the San Juan Islands, Semiahmoo Bay, and Holmes Harbor improved from depressed to moderately healthy or healthy levels of abundance.



Forage fish swim through a forest of kelp. / John Trone

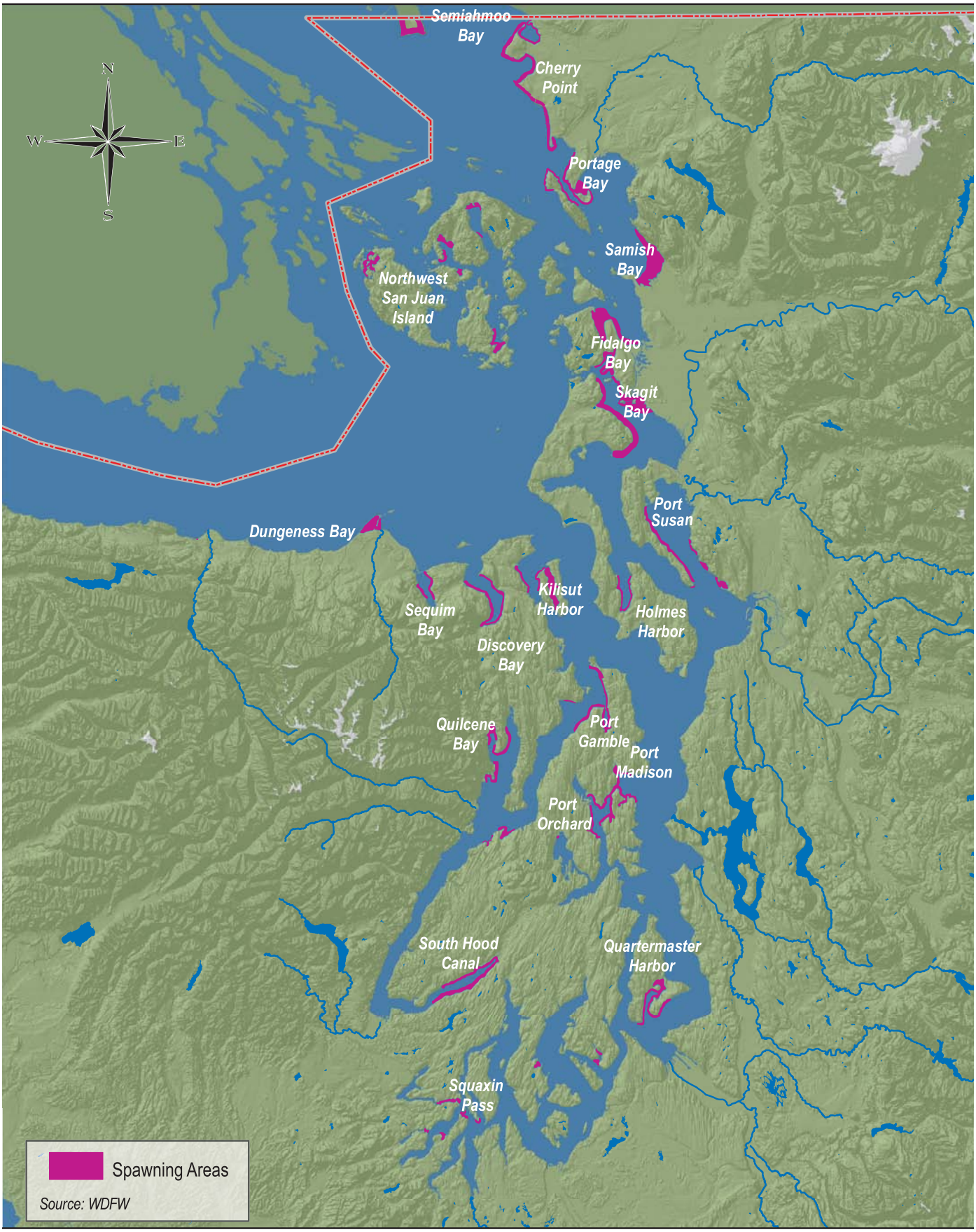
Abundance of Spawning Herring in Puget Sound 1993-2003



Source: WDFW

Of 19 herring stocks in Puget Sound, 15 are healthy or moderately healthy.

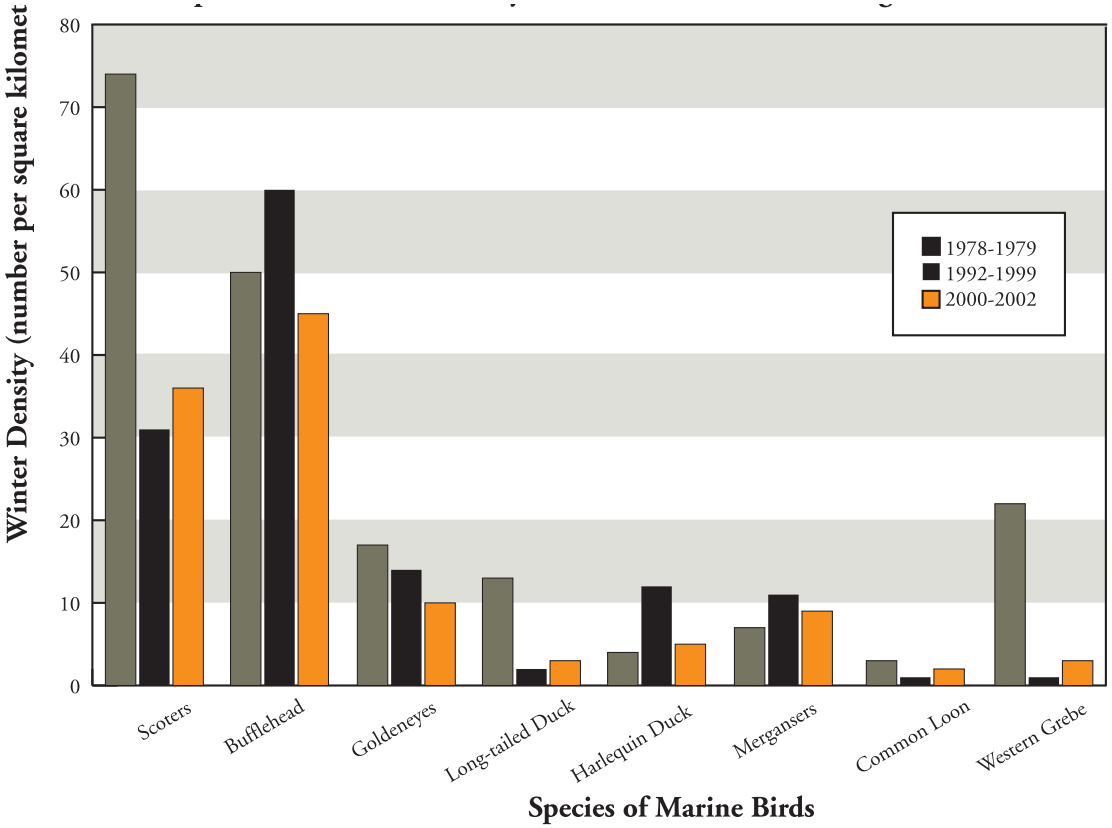
Puget Sound Herring Spawning Areas



INDICATOR: Marine Birds

The fall and winter are the best times to view marine birds in Puget Sound when thousands of migratory ducks, geese, diving birds, and shorebirds descend from the north and the interior. They rely on Puget Sound's productive waters, mudflats, and salt marshes to refuel and rest before returning to their nesting grounds in the spring.

Puget Sound provides food, breeding, nesting, and rearing habitat for more than 100 types of marine birds in the Sound either year-round or seasonally. A number of marine birds have declined in Puget Sound during the last few decades. In particular, Western grebes and surf scoters have shown significant declines since the 1970s.



Source: WDFW

Western Grebes

Grebes are fish-eating birds that breed inland near wetland areas. They winter in large flocks on the coast or Puget Sound. WDFW placed western grebes on its species of concern list because of sharply declining numbers.

Status

While all four grebe species that winter in Puget Sound have declined during the last 20 years, western grebe populations have shown striking declines of about 95 percent.

Trend

Southern Puget Sound, Hood Canal, and portions of northern Puget Sound have shown the greatest decline in western grebe populations during the last nine years. Western grebe populations in central Puget Sound near Bainbridge Island have stabilized in recent years.

Surf Scoters

Surf scoters are diving ducks that breed in Canada and Alaska and winter in Puget Sound. Scoters prey on mollusks, crustaceans, and herring eggs, which may give them the nutritional boost they need to migrate to areas where they molt and spend the summer. Declining populations of one of the most common sea ducks found in Puget Sound is disturbing.

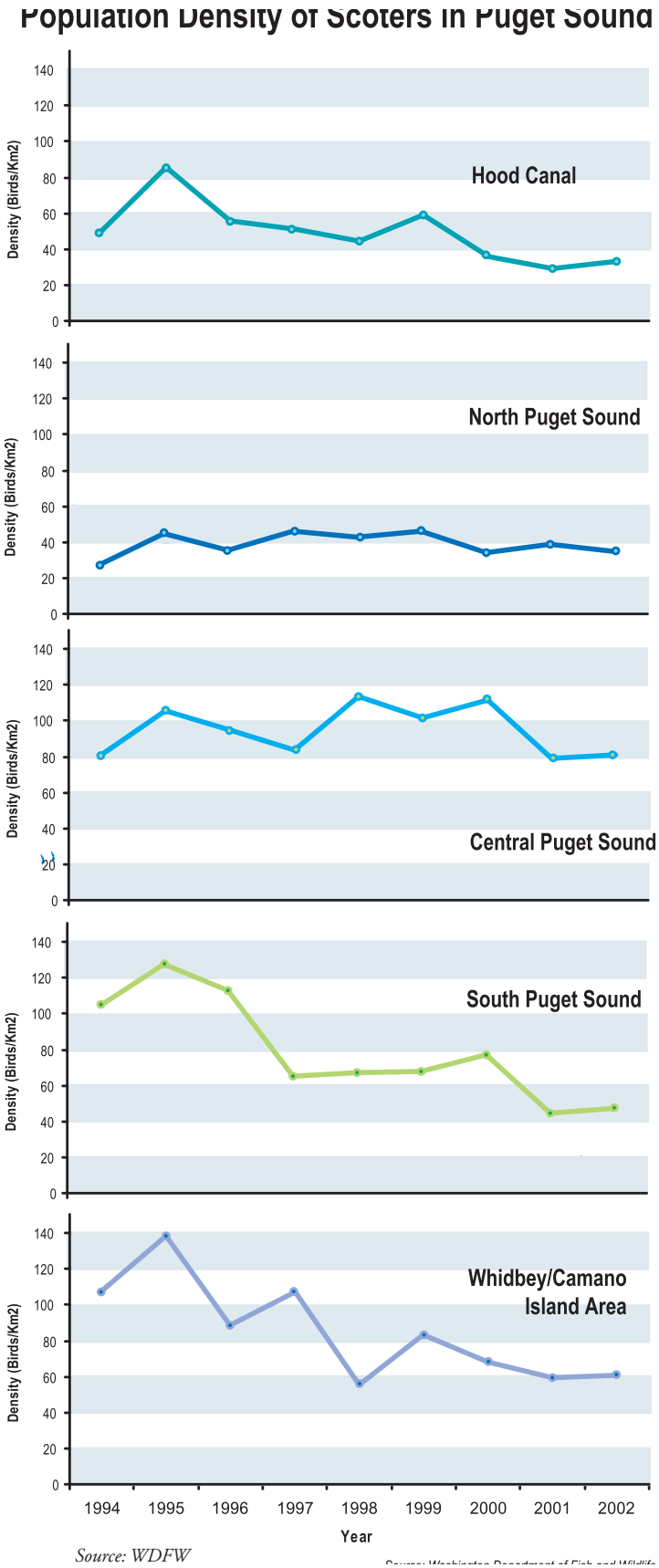
Status

WDFW is concerned with the relatively low numbers of scoters wintering in Puget Sound and has initiated efforts to investigate the status and cause for declining numbers of these birds.

Trend

Scoters have decreased throughout the region during the past nine years. South Sound populations have declined by 69 percent since 1995. In some areas of northern Puget Sound and Hood Canal, populations have declined by 57 percent since the mid-1990s. Populations in central Puget Sound and certain areas of northern Puget Sound are more stable.

Surf scoters / Mike Yip



Source: WDFW

INDICATOR: Southern Resident Orcas

People never forget the first time they see a wild orca. To many people, no species captures the essence of Puget Sound better than orcas, also known as killer whales. Their image is recreated in Salish tribal art, plush toys, and in the pages of tourist brochures.

Four populations of orcas swim through the region, but only one group of about 85 whales, referred to as the southern resident orcas, consistently return to spend a portion of each year in Puget Sound and the Strait of Georgia. They serve as indicators of the health of the marine ecosystem because they are long-lived predators and they depend on prey in Puget Sound for several months.

Orcas tend to accumulate dangerously high levels of PCBs, DDT, and other pollutants in their bodies, which can affect their ability to reproduce and fight disease.

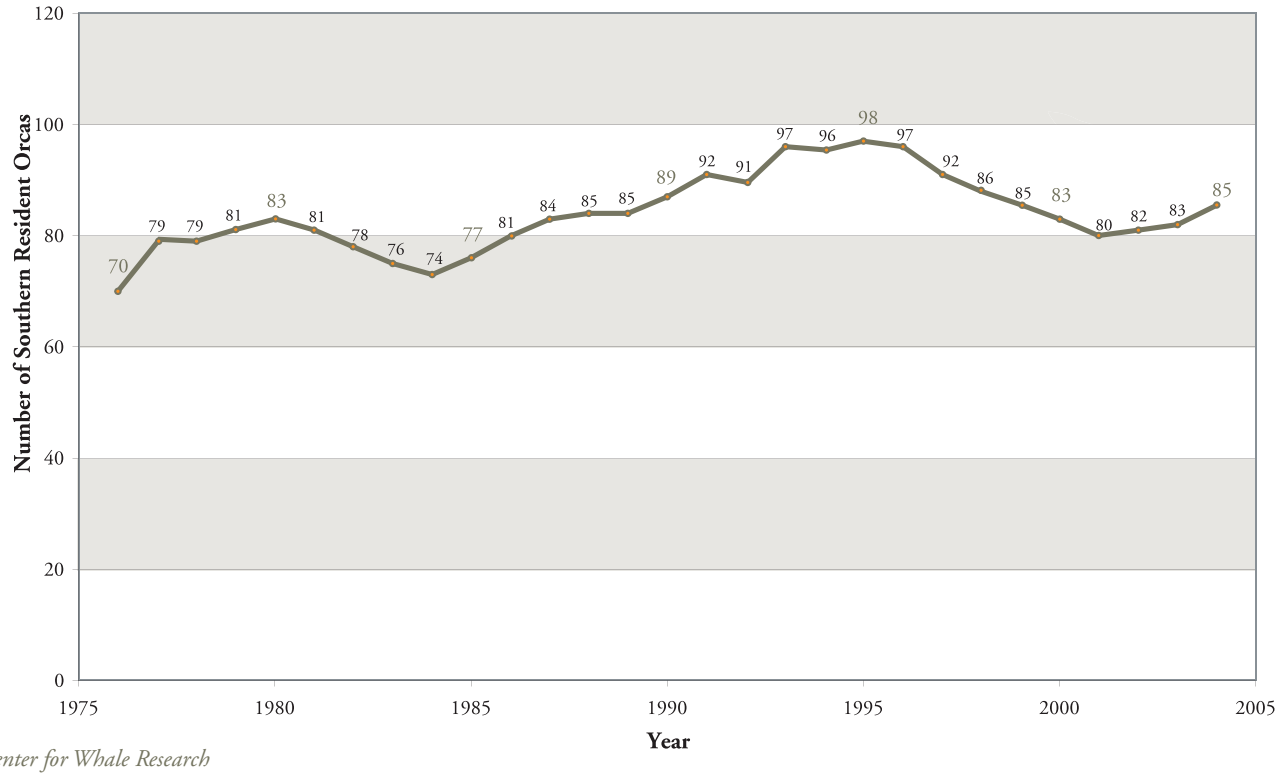
Status

The population of southern resident orcas has grown during the past several years. In 2003, researchers identified 83 whales in the population. In 2004, three births and one death increased the population to 85. One whale separated from the group is not included in the count.

Trend

Little information exists prior to the first orca census conducted in 1974. Researchers estimate that the size of the pre-1850s southern resident orca populations may have been about 200 whales. Models suggest that the population in the mid-1960s was about 95 whales. Only about 70 whales remained in the mid-1970s. Populations have increased from that low point with alternating periods of growth and decline. A steep decline from 98 to 80 whales occurred from 1995 to 2001, but the population of the southern resident orcas has gradually increased since then.

Number of Southern Resident Orcas 1976-2004



Orca / *Center for Whale Research*

The Partnership's Work to Recover Species

The Action Team partnership is working to achieve balanced, stable and self-sustaining populations of all native species in Puget Sound. Efforts to clean up and prevent pollution, and to protect and restore habitat contribute substantially to rebuilding a Puget Sound capable of supporting a broad diversity and abundance of species.

In addition, the Action Team partnership also focuses recovery work directly on species of particular concern, identifying the threats they face, protecting their habitat, and developing recovery plans.

Chinook salmon / WDFW

Recovering Salmon

Causes of salmon decline include habitat loss, over-harvesting, competition from hatchery fish, dams, and other projects that alter the flow of water in rivers and streams.

Shared Strategy for Puget Sound is a collaborative effort of local, state, tribal, and federal government agencies, conservation groups, businesses, and citizens to develop a recovery plan for Puget Sound chinook and bull trout. The plan will include commitments to specific actions that will protect and restore salmon runs across Puget Sound. Shared Strategy provides an excellent framework for organizing and coordinating the large number of local salmon recovery efforts throughout Puget Sound, and especially the work of 14 local watershed groups that are each writing chapters of the plan.

Action Team staff are developing the nearshore chapter. The chapter focuses on the nearshore and marine environments of Puget Sound and what needs to be done for salmon recovery in those areas. As part of this effort, the Action Team staff convened a basin-wide Nearshore Policy Group to help develop the proposed policies and commitments for the nearshore environment.

The Shared Strategy recovery plan will include recovery targets for depressed chinook and bull trout populations and outline actions needed to meet the targets for each watershed in the Puget Sound basin. Shared Strategy will deliver a draft of the chinook and bull trout regional recovery plan to NOAA Fisheries in June 2005. A similar effort by the Hood Canal Coordinating Council is underway; it is preparing a recovery plan for Hood Canal summer chum that is also due in June 2005.

Tiger rockfish / Jennifer Vanderhoof

Recovering Forage Fish

Stocks of herring and other forage fish may be affected by:

- Loss of critical nearshore habitat, especially eelgrass beds where herring lay their eggs.
- Heavy predation from salmon, harbor seals, and hake.
- Changes in water conditions, such as temperature, salinity, and dissolved oxygen.
- Reduced food supplies.
- Over-harvest.

WDFW adopted a Forage Fish Management plan in 1998 that stresses a conservative approach and guides harvest plans for each stock. The plan identifies spawning surveys as a high priority for forage fish management.

Marine Reserves

A powerful tool for the recovery of rockfish and other marine species is the creation of protected areas closed to most or all fishing. These areas allow fish to mature to their full reproductive potential to replenish fish populations in surrounding areas. WDFW has designated 18 conservation areas and marine preserves in Puget Sound, and intends to establish a network of marine refuges in the Sound. State and local governments have established other marine reserves that offer protection.

Recovering Rockfish

Fishing is probably the major cause of decline in rockfish. Consequently, WDFW and the Fish and Wildlife Commission have established shorter seasons and more restrictive catch limits. Last fall, the Commission enacted seasonal closures for rockfish, but allowed people to keep one rockfish, if it was unintentionally caught while they were fishing for salmon or lingcod. The Commission closed fishing in Hood Canal for most species, including rockfish, lingcod, and forage fish until oxygen levels improve.

WDFW is developing a conservation plan for rockfish. As of November 2004, researchers were nearly finished with the review of status and trends for populations of some depleted species. The plan will include maps of critical rockfish habitat and recommendations for the use of marine protected areas and other management actions to protect rockfish populations.

The Northwest Straits Commission and the marine resource committees worked with WDFW and a variety of partners and citizen volunteers to produce spawning inventories for surf smelt and sand lance in the seven northern counties of Puget Sound and for Mason and Thurston counties in south Sound. WDFW will make the data available on its Web site. Mapping forage fish habitat allows local governments to protect these areas through local land use, growth management, and shoreline management programs.

Recovering Marine Birds

Marine bird declines may be related to depressed forage fish populations and less availability of other food sources. Disturbances during resting, breeding, and rearing may be another factor. Loss of mudflat, marsh, eelgrass, and wetland habitat has a major impact on marine bird populations.

Center for Whale Research

Recovering Orcas

The federal government, the state, and Canada are all currently working on recovery plans for orcas. In 2003, NOAA Fisheries listed the southern resident orcas as a depleted stock under the U.S. Marine Mammal Protection Act. NOAA will complete a draft conservation plan for the southern resident orcas in 2005. In December 2004, NOAA Fisheries announced that it is proposing to list the southern resident orcas as threatened under the ESA. The Washington Fish and Wildlife Commission placed the southern resident orcas and other transient populations that visit Washington waters on the state's endangered species list in 2004. WDFW is working with U.S. and Canadian agencies to develop and coordinate recovery plans for orcas.

WDFW researchers have several studies underway to learn more about population size, migration routes, and habitat needs of marine birds. They are also working to identify and control human stresses to marine birds. This information will help the agency develop a marine bird recovery plan. Studies include:

- Examination of marine bird tissues to understand their foraging habits, discover what the birds eat, and where they put on most of their weight.

- A four-year surf scoter study with the U.S. Geological Survey in San Francisco Bay, where scoters are also declining. The agencies are using satellite tracking devices to find out where the birds go during the part of the year when they leave Puget Sound and San Francisco Bay. The study will help WDFW identify habitat threats, which the birds may be encountering during their breeding cycle.

- WDFW has restricted the use of gill nets in some areas because they entangle diving birds. The agency also supports efforts to clean up abandoned "ghost" nets that entangle birds and other marine life. The agency has set new limits to the number of surf scoters that hunters can take. They survey the numbers of scoters taken by licensed hunters to get information on the size of the wintering population.

Researchers believe the decline in southern resident orca populations has many causes. In the 1960s, marine park hunters captured orcas for their parks. The capture of young whales in the 1960s left fewer adults for breeding in the 1980s.

Whale deaths in the 1990s may be the legacy of high levels of pollution in the 1960s and 1970s. Studies of harbor seals indicate that high levels of pollutants, such as PCBs, accumulated in the tissues of Puget Sound marine mammals in the 1970s. Orca mothers carry high burdens of pollutants in their bodies that they transfer to their fetuses and nursing young during their critical developmental stages.

Low salmon runs in the 1990s, the preferred prey for orcas, and the availability of year-round salmon may be another factor for the decline. Further, orcas draw spectators wherever they go in Puget Sound and the noise and interference from commercial and private boats may hamper their communication, navigation, and hunting. Noise from sonar and seismic studies also may affect the health of orcas.

In advance of a recovery plan, a number of organizations and agencies in Washington state and British Columbia have developed voluntary guidelines for vessels, kayaks, and other craft watching orcas. Vessels that follow the guidelines are less disturbing to normal killer whale activities.

Species Success Stories

Conservation Districts Work with Landowners to Improve Salmon Habitat
CDs manage projects and educate landowners to become better stewards of Puget Sound. CD staff helped almost 10,500 people protect water quality and salmon habitat in 2003 and 2004. Other CD achievements in Puget Sound include:
- Completion of 60 projects to improve salmon habitat.
- Distribution of 65,000 native plants to landowners to enhance stream, wetland, and estuarine habitat.
- Conducting water quality monitoring at 31 stations.

Science for Forage Fish Directs Stewardship in the San Juans
The San Juan Marine Resource Committee worked with the Friends of the San Juans, a local non-profit organization, to assess forage fish beach spawning habitat on 600 beaches on 24 islands in the San Juan Archipelago. The data helped identify spawning sites on almost 13 miles of San Juan shorelines. The Friends of the San Juans is using the spawning surveys to help residents become good stewards of the nearshore habitat, an area critical to forage fish survival. The group trains shoreline landowners to protect forage fish spawning habitat on their property, and have helped educators teach about forage fish in schools. They provided the spawning area data to county planners to use in their 2004 critical areas ordinance update. Money from the 2003–2005 PIE fund helps support their education work.

Orca Network
The southern resident orcas are likely the most studied and loved population of whales in the world, in large part due to organizations such as the Orca Network. The Orca Network observes whales and helps keep them from harm. Hundreds of volunteers belong to the group's sighting network, which tracks the paths of orcas through Puget Sound and the Georgia Basin. Sighting reports help people understand the movements, behavior, and population trends of the at-risk orca communities. They encourage safe whale-watching etiquette and coach people about what they can do to protect orcas, salmon, and their habitat. The Action Team's PIE fund has helped finance the work of the Orca Network.

Fixing Roads for Salmon
WSDOT identifies and repairs or replaces highway culverts that prevent salmon and other fish from accessing habitat for spawning. In 2003 and 2004, the agency removed fish barriers at nine sites in the Puget Sound region.

Continuing Challenges to Recover Species

Puget Sound species are the ultimate indicators of the health and vitality of the Sound. Protecting the Sound's key species requires protecting the integrity of the food web, which in turn requires effectively addressing toxic contamination and loss of habitat. Puget Sound's species cannot be saved without saving all of Puget Sound.

- Long-lived species with low reproductive rates, such as rockfish and orca, are the most vulnerable to loss. Stringent safeguards are needed for these species as even small losses can have big and lasting ripple effects on the populations.
- Species-by-species recovery planning, the current mode, is complex and consumes a great deal of time and resources. Most human actions will affect many species. While a multi-species approach might be more complex at first, it would likely also be more effective and enduring, as well as more relevant and useful for resource managers, landowners, regulators, and others working to protect and recover species.
- More information is needed about the life histories and environmental requirement of species in decline, especially those that spend a portion of every year outside of Puget Sound. For example, orcas are fairly well studied while they are in Puget Sound, but little is known about where they go, what they do, and the threats they face during the part of the year when they leave the area.

The living resources of Puget Sound are the ultimate indicators of its health. The picture they paint is troubling.

Feather duster worms / Jennifer Vanderhoof

V. State of the Sound 2004
CONCLUSION

State of the Sound 2004 has provided information on the overall health of Puget Sound. It has described efforts by the Puget Sound Action Team partnership and others to protect and restore the Sound. Now it is time to return to the questions posed at the outset: How is the Sound's health? Is the work to protect and restore the Sound on the right track? What more must be done?

The information presented in this report reflects a mix of positive and negative news. A great deal of excellent work is being accomplished by thousands of committed people in government and the private sector, and this work is leading to significant improvements in areas of Puget Sound. The achievements highlighted throughout this report are testament to that good work.

What the accomplishments don't communicate is whether the work is solving the problems, at the scale necessary, to achieve the necessary goals. While this is a difficult question to answer with certainty, the environmental data that the Action Team staff assessed for this report suggest that the tremendous efforts to preserve the Sound are not yet equal to the scale of the problems.

The pace of change in the Puget Sound region is staggering. Population growth and the accompanying increases in impervious surfaces; alteration and loss of habitat; and a slew of toxic contaminants entering the water, are all challenging government and private sector efforts to keep even with, or get ahead of, the problems.

Unfortunately, there isn't a simple solution in the quest to preserve a healthy Puget Sound and pass it on to future generations. The Sound's environment is like a mirror, reflecting back to society the cumulative impact of thousands of actions. While none of these actions alone may be significant enough to harm the Sound, taken together they add up to a significant injury.

These cumulative pressures on Puget Sound are driving a silent and slow motion crisis. While the Sound still appears beautiful, its diverse web of life is at risk. The building blocks of a healthy environment—clean water, abundant habitat, and an intact food web—continue to be eroded. Perhaps most worrisome, the health of the Sound's living resources—orca, rockfish, marine birds, and others—appear to be in jeopardy and may signal a broader systemic problem.

The goal of a healthy Puget Sound now and for future generations is still within reach, but to achieve it will require redoubling the effort and expanding the scale of work. What more must be done? How should efforts and resources best be concentrated to tackle these problems?

The *2005-2007 Puget Sound Conservation and Recovery Plan* outlines the Action Team partnership's collective thinking on the best next steps in the short term. Action Team staff submitted the plan to the Governor and the Legislature in November 2004 for consideration in the 2005 legislative session.

In the longer term, the following strategies and principles must form the foundation for continuing efforts to save the Sound.

Preventing further environmental losses is far cheaper and more effective than trying to repair the damage later. Governments and the private sector must invest adequate resources to prevent further loss and damage. Prevention requires careful planning, making sure that growth management and shoreline management plans, spill prevention plans, wastewater treatment plans, and myriad other plans are all adequate and in force to protect the Sound. Prevention also requires effective and comprehensive

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enforcement of the laws and standards that safeguard the environment.

With an estimated million-plus new residents settling in the Puget Sound region during the next 20 years, and a significant amount of land yet to be developed in the basin, how well the region plans for and actually accommodates this new growth and development will determine Puget Sound's health for the long term.

The scale of efforts to protect and restore the Sound must be sufficient to address the scale of the problems. The current reach of state programs and the level of investment are not sufficient to get the job done at the pace and scale necessary for success. Larger investments of human and financial resources are needed to safeguard the health of Puget Sound now and for tomorrow's citizens.

Informed and involved citizens are essential to achieve a healthy and living Puget Sound, both in their own behaviors and choices, and in the actions they expect and will support from all levels of government. Washington State must continue to invest in environmental literacy, outreach, and awareness. Those working on these issues must clearly demonstrate the links between environmental health and other key issues people care about—quality of life, personal health, and a vibrant, enduring economy.

Creativity and innovation must be marshaled to get the results and improvements needed in the environment. To paraphrase Einstein, the same level of thinking that created these problems will not be sufficient to solve them. New approaches to these complex challenges are required. Creativity and innovation will be more likely when the polarization and stalemate on these issues is set aside and diverse people work together to think through solutions. Putting aside conventional wisdom and experimenting is a challenge for all interested in and affected by these issues.

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State of the Sound 2004
GUIDE TO TERMS

Puget Sound Action Team

Action Team staff	Puget Sound Action Team Staff
Action Team Partnership	Puget Sound Action Team Partnership Agencies
PIE fund	Public Involvement and Education Fund
PSAMP	Puget Sound Ambient Monitoring Program

Washington State Agencies

Agriculture	Department of Agriculture
Ecology	Department of Ecology
WDFW	Department of Fish and Wildlife
CTED	Department of Community, Trade and Economic Development
DOH	Department of Health
DNR	Department of Natural Resources
IAC	Interagency Committee for Outdoor Recreation
WSDOT	Department of Transportation
Board of Health	State Board of Health

Federal Agencies

EPA	U.S. Environmental Protection Agency
NOAA	National Oceanic and Atmospheric Administration

Local Agencies

CDs	Conservation Districts

Academic Institutions

Sea Grant	University of Washington Sea Grant Program
WSU Extension	Washington State University Extension

Other Acronyms

CAO	Critical Areas Ordinance
DDT	Dichloro-diphenyl-trichloroethane
ESA	Federal Endangered Species Act
GMA	Washington Growth Management Act
LID	Low Impact Development
PAHs	Polycyclic Aromatic Hydrocarbons
PBDEs	Polybrominated Diphenyl Ethers
PBT	Persistent, Bioaccumulative Toxic
PCBs	Polychlorinated Biphenyls
ppb	Parts per billion
ppm	Parts per million
NPDES	National Pollutant Discharge Elimination System
SMA	Shoreline Management Act
SMP	Shoreline Master Program
TMDL	Total Maximum Daily Load

Gary Wilson

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NOTES

[1] Pacific Coast Shellfish Growers Association.

[2] Macdonald, R.W., E.A. Crecelius. 1994. "Marine sediments in the Strait of Georgia, Juan de Fuca Strait, and Puget Sound: What can they tell us about contamination?" *1994 Canadian Technical Report of Fisheries and Aquatic Sciences No. 1948*. pp. 101-137.

[3] *Puget Sound Update*, 2002, Puget Sound Action Team. Olympia, Washington. pp. 79-80.

[4] *Superfund Fact Sheet*, U.S. Environmental Protection Agency, August 2000. *EPA Spreadsheet,* U.S. Environmental Protection Agency, September 2004.

[5] Glasoe, S., Christy, A. 2004. *Literature Review and Analysis: Coastal Urbanization and Microbial Contamination of Shellfish Growing Areas.* Puget Sound Action Team.

[6] Thom, R.M., D.K. Shreffler. 1994. *Shoreline Armoring Effects on Coastal Ecology and Biological Resources in Puget Sound.* Preliminary Report Prepared for Washington Department of Ecology's Shorelands and Coastal Zone Management Program.

[7] Washington Department of Ecology Web Page: http://www.ecy.wa.gov/programs/sea/pugetsound/species/salmon.html.

[8] In December 2004, NOAA Fisheries announced that it proposed to list the southern resident population of orcas as threatened under ESA, (69FR76673).

[9] NOAA Fisheries, formerly known as National Marine Fisheries Service, deemed not warranted under ESA the listing of the Puget Sound/Strait of Georgia evolutionary significant unit (ESU) of chum salmon (63FR11774) and the Puget Sound and Olympic Peninsula ESUs of steelhead (61FR41541).

[10] Myers, J.M. et al., 1998. *Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California*. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-35. 433 p.

[11] Washington Department of Fish and Wildlife Web Page: http://wdfw.wa.gov/fish/papers/ps_chinook_management/harvest/2003-04_annual_report.pdf

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Puget Sound Action Team Partnership

The Puget Sound Action Team is the state's partnership for Puget Sound. The Action Team partnership defines, coordinates, and puts into action the state's environmental and sustainability agenda for the Sound. Representatives from the following groups serve on the Action Team:

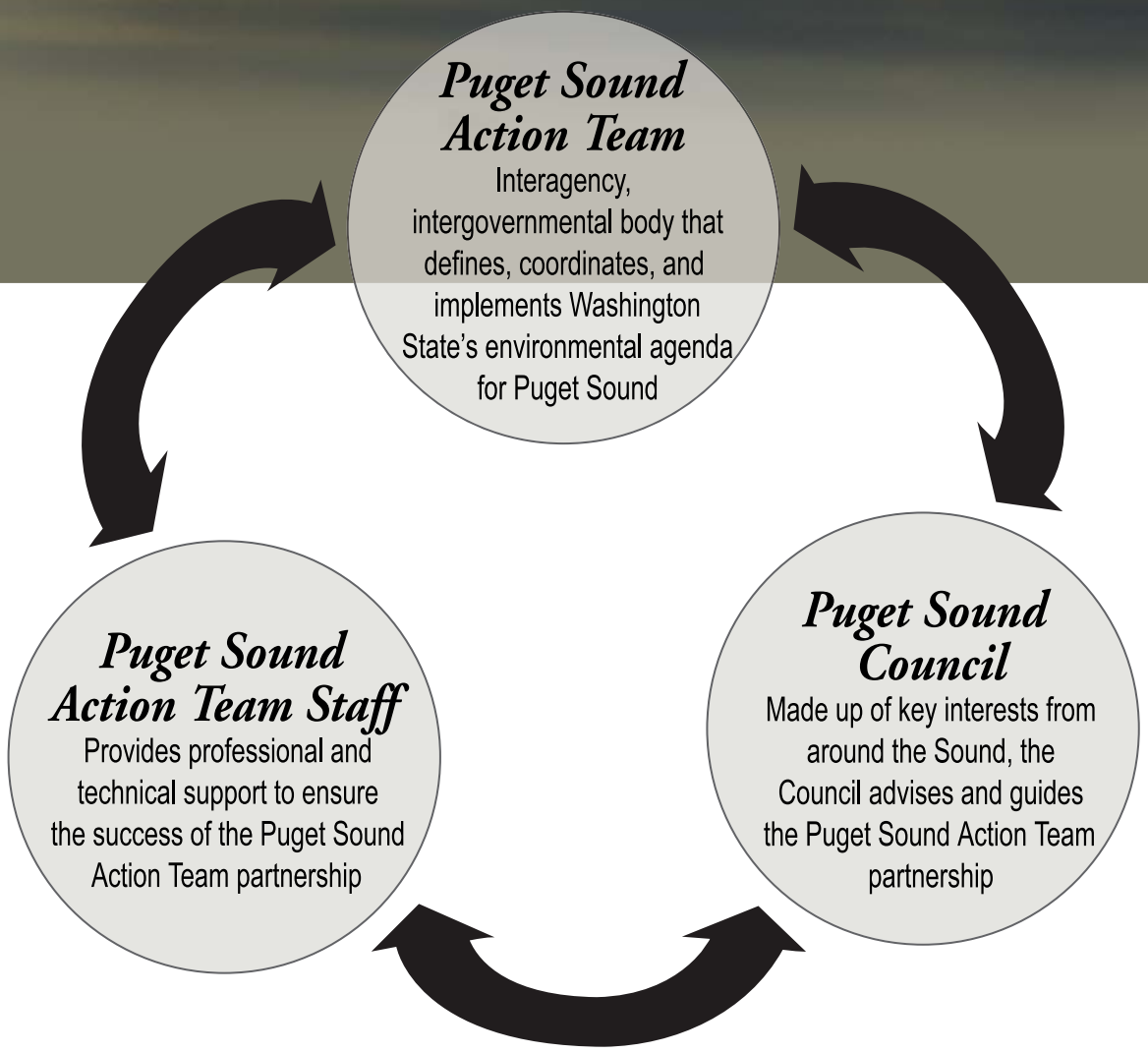
Washington State Government, *directors of the following agencies*
- Community, Trade and Economic Development
- Conservation Commission
- Department of Agriculture
- Department of Ecology
- Department of Fish and Wildlife
- Department of Health
- Department of Natural Resources
- Department of Transportation
- Interagency Committee for Outdoor Recreation
- Parks and Recreation Commission

Tribal Governments
- Tulalip Tribes, representing Puget Sound Tribes

Local Government
- City of Burien, representing Puget Sound cities
- Whatcom County, representing Puget Sound counties

Federal Government *(non-voting)*
- NOAA Fisheries
- U.S. Environmental Protection Agency
- U.S. Fish & Wildlife Service

Chair: Director of the Puget Sound Action Team



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